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/09 **Date: 02/01/2024**

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 M.Sc. Part-II (Sem. III & IV) 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 M.Sc. Part-II (Sem. III & IV) as per NEP-2020 (1.0) degree programme under the Faculty of Science and Technology.

M.Sc.Part-II (Sem. III & IV) as per NEP-2020 (1.0)			
1.	Computer Science	7.	Biochemistry (HM)
2.	Data Science	8.	Biotechnology (HM)
3.	Information Technology (Entire)	9.	Biotechnology
4.	M.C.A.	10.	Medical Information Management
5.	Food Science & Nutrition	11.	Environmental Science
6	Food Science & Technology	12.	

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:

1	The Dean, Faculty of Science & Technology	8	P.G. Admission/Seminar Section
2	Director, Board of Examinations and Evaluation	9	Computer Centre/ Eligibility Section
3	The Chairman, Respective Board of Studies	10	Affiliation Section (U.G.) (P.G.)
4	B.Sc. Exam/ Appointment Section	11	Centre for Distance Education

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

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Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Master of Science (Biotechnology)
Part II

Under

Faculty of Science and Technology

(To Be Implemented From Academic Year 2024-25)

INDEX

1. **Preamble:**

As per the NEP 2020 guidelines this updated syllabus is prepared for first year post graduate students of Biotechnology. At this level, to develop their interest towards Biotechnology as applied science and prepare them for academic and industrial exposure simultaneously. Introduction of life science subjects will help to form foundation of concepts for students. The interdisciplinary approach with vigor and depth is compatible to the syllabi of other universities, at the same time is not rigid for the students at first year of their post-graduation. The units in the syllabus are well defined with scope and the number of lectures. The references are mentioned with relevance.

2. **Duration:** Two-Year Full-Time Course with 4 semesters.

3. **Eligibility:**
   - B. Sc. with Biotechnology/Microbiology/Botany/Zoology/Biochemistry/Food Science and Technology/Nanoscience and Technology/Life Sciences as principle subjects/ B.Sc. Agri/B.E./M.B.B.S./B.Pharma.
   - A student has to qualify the entrance examination conducted by Shivaji University for the respective academic year.

4. **Medium of Instruction**: English

5. **Programme Structure**

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (Biotechnology) Part – I (Level-6.0)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures /(Hours /week)	Practical (Hours/week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam Hours
Semester-I										
Major Mandatory Theory	MMT-101	4	--	4	80	32	3	20	8	0.5
	MMT -102	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	MET-103 A **OR** MET-103 B **OR** MET-103 C	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	MMPR -104	--	8	4	100	40	12	-	-	-
	MMPR -105	--	4	2	50	20	6	-	-	-
Research Methodology	RM-106	4	--	4	80	32	3	20	8	0.5
Total				22	470			80		
Semester-II										
Major Mandatory Theory	MMT-201	4	--	4	80	32	3	20	8	0.5
	MMT -202	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	MET-203 A **OR** MET-203 B **OR** MET-203 C	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	MMPR -204	--	8	4	100	40	12	-	-	-
	MMPR -205	--	4	2	50	20	6	-	-	-
OJT/FP	OJT-206 OR FP-206	--	--	4	--	--	--	100	40	0.5
Total				22	390			160		
Total (Sem I + Sem II)				44	860			240		

• MMT – Major Mandatory Theory • MMPR – Major Mandatory Practical • MET – Major Elective Theory • MEPR – Major Elective Practical • RM - Research Methodology • OJT/FP- On Job Training/ Field Project	• Total Marks for M.Sc.-I : **1100** • Total Credits for M.Sc.-I (Semester I & II) : 44 ***Separate passing is mandatory for University and Internal Examinations***
*Evaluation scheme for OJT/FP shall be decided by concerned BOS	
Requirement for Entry at Level 6.0: B. Sc. with Biotechnology/Microbiology/Botany/Zoology/Biochemistry/Food Science and Technology/Nanoscience and Technology/Life Sciences as principle subjects/ B.Sc. Agri/B.E./M.B.B.S./B.Pharma. Student must qualify the entrance examination conducted by Shivaji University for the respective academic year.	
Requirement for Exit after Level 6.0: Students can exit after completion of Level 6.0 with Post Graduate Diploma in Biotechnology.	
Requirement for Entry at Level 6.5: Completion of Level 6.0	

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (Biotechnology) Part – II (Level-6.5)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures + Tutorial (Per week)	Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-III										
Major Mandatory Theory	MMT-301	4	--	4	80	32	3	20	8	0.5
	MMT -302	4	--	4	80	32	3	20	8	0.5
	MMT -303	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	MET-304 A **OR** MET-304 B	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	MMPR -305	--	4	2	50	20	6	-	-	-
ResearchProject	RP-306		8	4	100	40	12#			
Total				22	470			80		
Semester-IV										
Major Mandatory Theory	MMT-401	4	--	4	80	32	3	20	8	0.5
	MMT -402	4	--	4	80	32	3	20	8	0.5
	MMT -403	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	MET-404 A **OR** MET-404 B **OR** MET-404 C	4	--	4	80	32	3	20	8	0.5
ResearchProject	RP-405	--	12	6	150	60	18##	--	--	--
Total				22	470			80		
Total (Sem III + Sem IV)				44	940			160		

<table>
<tr><td>• MMT – Major Mandatory Theory
• MMPR – Major Mandatory Practical
• MET – Major Elective Theory
• MEPR – Major Elective Practical
• RP- Research Project</td><td>• Total Marks for M.Sc.-II : 1100
• Total Credits for M.Sc.-II (Semester III & IV) : 44
Separate passing is mandatory for University and Internal Examinations</td></tr>
<tr><td colspan="2"># Evaluation scheme for Research Project shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">## Evaluation scheme for Research Project shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">Requirement for Exit after Level 6.5:
Students can exit after completion of Level 6.5 with Post Graduate in Biotechnology.</td></tr>
</table>

Semester I		Semester II	
MMT-101	Cell Biology (4Cr)	MMT-201	Genetics and Immunology (4Cr)
MMT-102	Basics in Microbiology (4Cr)	MMT-202	Molecular Biology (4Cr)
MET-103A MET-103B MET-103C	Biomolecules and Instrumentations (4Cr) **OR** Microbial Diversity and Systematics (4Cr) **OR** Biostatistics and Computer (4Cr)	MET-203A MET-203B MET-203C	Cellular Metabolism (4Cr) **OR** IPR and Bioethics (4Cr) **OR** Animal Physiology and Endocrinology (4Cr)
MMPR -104	Lab Course I (4Cr)	MMPR -204	Lab Course III (4Cr)
MMPR -105	Lab Course II (2Cr)	MMPR -205	Lab Course IV (2Cr)
RM- 106	Research Methodology (4Cr)	OJT- 206 **OR** FP- 206	On Job Training (4Cr) **OR** Field Project (4Cr)
Semester III		**Semester IV**	
MMT-301	Plant and Animal Tissue Culture (4Cr)	MMT-401	Medical Biotechnology (4 Cr)
MMT-302	Genetic Engineering and Bioinformatics (4Cr)	MMT-402	Environment and Pharmaceutical Biotechnology (4 Cr)
MET-303	Industrial Biotechnology (4Cr)	MMT-403	Cancer Biology and Nanotechnology (4 Cr)
MET-304 A MET-304 B	Stem Cell Technology (4Cr) **OR** Clinical Research (4Cr)	MET-404A MET-404B MET-404C	Food and Agricultural Biotechnology **OR** Industrial Waste Management **OR** Quality assurance and validation
MMPR -305	Lab Course V (2Cr)	RP-405	Research Project (6 Cr)
RP- 306	Research Project (4Cr)		

6. **A) Programme objectives**

- Reconstruction and redesigning of the courses to suite local needs
- To emphasize on applied aspects of biotechnology
- To develop aptitude of students in the field of research
- To enrich of basic knowledge in areas of Biotechnology
- To provide quality teaching and training in multidisciplinary areas of Biotechnology and nurture students to meet the needs of the society and industry.
- To cater to the national and global requirement of trained manpower in the area of Biotechnology.
- To create and sustain excellent research and teaching ambience for future leaders and innovators.
- To establish collaborations with other academic institutions at national and international levels to reinforce education and research activities.
- To train the students in technology-based entrepreneurship for socio-economic development.
- Skill development training to bridge the gap between academia and industry.

B) Program Outcomes (POs)

The M.Sc., programme in Biotechnology is in high demand among life science programmes in the University. Successful completion of this programme will result in students;

- Having strong foundation in understanding of basic biology in both prokaryotic and eukaryotic systems at molecular level. Further the student will be able to learn cutting edge technology in the field of Biotechniques, Cell biology, Molecular Biology, Genetic Engineering, Bioinformatics, Plant, Animal and Microbial Biotechnology, Immunology, Nanotechnology, Medical, Pharmaceutical, Food and Environmental Biotechnology.
- Having hands-on practical skills along with their respective theoretical knowledge, this will help in their research carrier in academic institutions and industries.
- Having improved skills for teaching in academic institutions.
- Having competitive skills and spirit in the field of life sciences both in India and abroad for pursuing higher education.

7. Course Codes

Sr.	Course Name	Credit	Course code
M.Sc. Semester I			
Major Mandatory			
1	Cell Biology	4	MSU0325MML97G1
2	Basics in Microbiology	4	MSU0325MML97G2
3	Lab Course I	4	MSU0325MMP97G1
4	Lab Course II	2	MSU0325MMP97G2
5	Research Methodology	4	MSU0325RML97G
Major Elective			
6	Biomolecules and Instrumentations	4	MSU0325MEL97G1
	Microbial Diversity and Systematics		MSU0325MEL97G2
	Biostatistics and Computer		MSU0325MEL97G3
M.Sc. Semester II			
Major Mandatory			
1	Genetics and Immunology	4	MSU0325MML97H1
2	Molecular Biology	4	MSU0325MML97H2
3	Lab Course III	4	MSU0325MMP97H1
4	Lab Course IV	2	MSU0325MMP97H2
5	On Job Training	4	MSU0325OJ97H
	Field Project		MSU0325FP97H
Major Elective			
6	Cellular Metabolism	4	MSU0325MEL97H1
	IPR and Bioethics		MSU0325MEL97H2
	Animal Physiology and Endocrinology		MSU0325MEL97H3
M.Sc. Semester III			
Major Mandatory			
1	Plant and Animal Tissue Culture	4	MSU0325MML97I1
2	Genetic Engineering and Bioinformatics	4	MSU0325MML97I2
3	Industrial Biotechnology	4	MSU0325MML97I3
4	Lab Course V	2	MSU0325MMP97I1
5	Research Project	4	MSU0325RP97I
Major Elective			
6	Stem Cell Technology	4	MSU0325MEL97I1
	Clinical Research		MSU0325MEL97I2
M.Sc. Semester IV			
Major Mandatory			
1	Medical Biotechnology	4	MSU0325MML97J1
2	Environment and Pharmaceutical Biotechnology	4	MSU0325MML97J2
3	Cancer Biology and Nanotechnology	4	MSU0325MML97J3
4	Research Project	6	MSU0325RP97J
Major Elective			
5	Food and Agricultural Biotechnology	4	MSU0325MEL97J1
	Industrial Waste Management		MSU0325MEL97J2
	Quality assurance and validation		MSU0325MEL97J3

8. Syllabus

M. Sc. Biotechnology (Part II) (Level-6.5) (Semester III)
(NEP-2020)
(Introduced from Academic Year 2024-25)

Title of course – MMT 301 Plant and Animal Tissue Culture
Course code- MSU0325MML97I1
Total credits- 4

Course Objectives:

- Enable students to grasp the fundamental principles underlying Plant Tissue Culture (PTC) and Animal Tissue Culture (ATC).
- Equip students with the skills and knowledge related to specific techniques applied in both PTC and ATC.
- Encourage students to identify and comprehend the diverse practical applications of both PTC and ATC in scientific and research contexts.

Course Outcome: Upon completing the credits, students will be able to:

- Recall and describe the basic concepts underlying PTC and ATC.
- Comprehend the specific techniques employed in both PTC andATC.
- Apply the knowledge gained to recognize and explain various practical applications of both PTC and ATC

		60 Hrs
Credit I	**Introduction to PTC**	**15 Hrs**
	Introduction to plant tissue culture- Definition, History ,Cellular totipotency, techniques in plant tissue culture. **Infrastructure & Organization Of Plant Tissue Culture Laboratory- General and aseptic laboratory-** different work areas, equipment's and instruments required and other requirements. **Aseptic Techniques-** Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization, aseptic workstation and precautions to maintain aseptic conditions. **Culture Medium-** Composition of basal M.S. medium and preparation of media. **Callus Culture Techniques-** Introduction, principle, protocol, morphology and internal structure, genetic variations and applications. **Somatic Embryogenesis-** Introduction, principle, protocol, factors affecting, applications and limitations. **Organogenesis-** Introduction, principle, protocol, applications. **Ovary and ovule Culture Technique-** Introduction, principle, protocol, and applications.	
Credit II	**Different Techniques in PTC**	**15 Hrs**
	Anther & Pollen Culture Technique- Introduction, principle, protocol, factors affecting and applications. **Micropropagation-** Introduction, stages of Micropropagation, factors affecting, advantages and applications. **Different Pathways of Micropropagation**- Axillary bud proliferation, somatic embryogenesis, organogenesis and meristem culture. **Somaclonal Variation-** Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, applications and limitations. **Cell Suspension Culture Technique**- Introduction, principle, protocol, types, growth measurement, synchronization and applications. **Plant Protoplast Culture:-** History, Principle, protocol for isolation- Mechanical and Enzymatic, protoplast culture and importance.	

Credit III	**History and Introduction of Animal Cell culture**	**15 Hrs**
	History of animal cell culture **Requirements of Animal cell culture-** Characteristics of animal cell in culture, substrate for cell growth, Equipment's required for animal cell culture (Laminar air flow, CO_2 incubator, Centrifuge, Inverted microscope) **Culture media-** Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of media). **Laboratory design and layout-**Construction and services, layout of aseptic room (sterile handling area, laminar air flow, service bench), incubation (incubators, hot room), preparation area (media preparation, washing area, storage). **Cultured cells- Biology and Characterization-** Characteristics of cultured cells, cell adhesion, cell proliferation, cell differentiation, metabolism of cultured cells, Initiation of cell culture, Evolution and development of cell lines. **Characterization of cultured cells-** Morphology of cells, species of origin of cells, Identification of tissue of origin, transformed cells, Identification of specific cell lines. **Measurement of growth parameters of cultured cells-** Growth cycle of cultured cells, plating efficiency of cultured cells **Cell synchronization-** Cell separation by physical means, cell separation by chemical blockade **Senescence and apoptosis-** Cellular senescence, Measurement of senescence, Apoptosis, Measurement of apoptosis.	
Credit IV	**Basic techniques and applications of ATC**	**15 Hrs**
	Basic technique of mammalian cell culture- Isolation of tissue, disaggregation of tissue, measurement of viability, primary cell culture, Cell lines, Maintenance of cell culture, Subculture, Stem cell cultures **Scale up of Animal cell culture**-Scale up in suspension-stirrer culture, continuous flow culture, Airlift fermenter culture, Scale up in monolayer- Roller bottle culture, multisurface culture, multiarray disks and tubes, Microcarrier culture, Perfused monolayer culture. **Contamination-** Concept and Sources of contamination, types of microbial contamination, eradication of contamination. **Applications of cell culture**-In transplantation, and tissue engineering, monoclonal antibodies, culture based vaccine, valuable recombinant product, cloning, ethics and morality. **Stem Cell technology:** General introduction and applications.	

Reference Books: -

- Introduction to plant tissue culture- M.K. Razdan
- Plant tissue culture-Theory & practice-S.S.Bhojwani & M.K. Razdan
- Plant tissue culture-Kalyankumar Dey
- Biotechnology- B.D. Singh
- A text book of Biotechnology- R.C. Dubey 6] Plant tissue culture-U.Kumar
- Plant cell, tissue & organ culture-Gam Borg & Phillips 8] Fundamentals of Biotechnology-S.S. Purohit
- Biotechnology- H.S. Chawla
- Crop Improvement In biotechnology- H.S.Chawla
- Animal tissue culture- Paul
- Culture of animal cell 3rd edition-R Ian Freshney
- Animal cell culture- R.W.Masters
- Animal biotechnology-M.M.Ranga
- Animal biotechnology-R.Sasidhara

Title of course – MMT 302 Genetic Engineering and Bioinformatics
Course code- MSU0325MML97I2
Total credits- 4

Course Objectives:

- To make students aware of fundamentals of genetic engineering.
- To make the student aware of basics of gene isolation.
- To study working of molecular markers.
- To understand concepts bioinformatics.

Course outcome:-: After completing the credits students should gain knowledge about:

- Concept of rDNA technology.
- Isolation of gene and nucleic acid hybridization.
- Applications of cloning and molecular markers.
- Various tools of bioinformatics.

		60 Hrs
Credit I	**Enzymes in r-DNA technology**	**15 Hrs**
	Introduction and Scope, Enzymes and its applications, Restriction enzymes- types (I, II, III), nomenclature, recognition sequences, cleavage patterns, modification of cut ends (linkers and adaptors), application –RFLP, Restriction mapping. Alkaline phosphatases, DNA ligases T4 and E. coli Ligases, Methylase , Reverse Transcriptases, Polymerases- Klenow enzymes, T4 DNA polymerases, Taq DNA polymerases, Polynucleotide kinase. Cloning Vectors: Introduction, Properties of good vectors , Cloning & expression vectors, Types- E.coli vector- plasmid – pBR 322 and pUC18 Bacteriophage vectors – phage vector, M 13 Vectors (replacement e. g. EMBL 3, EM BL 4 and insertional e.g gt 10 and gt 11) Cosmid vector, Phagemid vector e.g pBlue script II KS/SK, Yeast vector- YAC and BAC , Animal vectors – Retroviral , Plant vector – Ti plasmid, Ri plasmid, shuttle vector- e.g pJBD 219, Ta clonig vector (introductiory) ,Selection of recombinant vector.	
Credit II	**Nucleic Acid Hybridisation and Isolation of Gene**	**15 Hrs**
	Nucleic Acid Hybridisation Nucleic Acid and plasmid purification. Probe Preparation, Methods of labelling probes. Radio labelling – Nick translati on, End labeling, Primer extension, Non Radiolabelling – Biotin, dioxygenin, fluorescent dyes, Applications of probes. DNA Sequencing and blotting technique- Maxam Gilbert method , Sanger Coulson method, Automated DNA sequencing, Southern Blotting, Northern Blotting, Western blotting , Dot blotting. Isolation of Gene- Chemical synthesis, Phosphotriester approach , Phosphitetriester approach, Isolation desired gene from DNA, Isolation of specific gene with PCR. cDNA and genomic library. Screening of libraries immunological screening and colony or plaque hybridization.	
Credit III	**Cloning methodologies and Molecular Markers**	**15 Hrs**

	Cloning methodologies Construction of plasmid – e. g. Somatostatin, Inse rtion of foreign DNA into host cells , Agrobacterium mediated gene transfer, Transformation, Transfection . Chemical methods- CaCl2 coprecipitation, polycation mediated gene transfer. Physical methods- Liposomes, microingection, electroporation, biolistics. screening of recombinants, Direct selection , Insertional inactivation selection , Blue white selection, Expression based screening (HART) Fluorescent Activated Cell Sorter, South –Western S creening. Molecular Markers- Introduction – Morphological , Biochemical, RFLP, RAPD, AFLP, STRS, QTL, SSR.	
Credit IV	**Bioinformatics**	**15 Hrs**
	Introduction to Bioinformatics History of bioinformatics: **Multidisciplinary approach of bioinformatics, Computers in Biology and Medicines, Internet, and** **related programs; Networking HTTP, HTML, WAN, LAN, MAN,** **applications in communication.** 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. Introduction to Genomics and Genome databases: Introduction, Databases, Data, Nucleic acid sequence database, Gene Bank, EMBL, DDBJ. Genomics: Human Genome Project (HGP), Goal and applications, final draft of HGP (complete information resources covered). **Sequence Alignment and Phylogenetic analysis** Sequence Alignment: Introduction, Protein sequence, Nucleic acid sequence, Pair wise sequence alignment, Multiple sequence alignment, Local and Global sequence alignment. Algorithm used in sequence alignment: Matrices- Dot matrix, PAM, BLOSSOM. Phylogenetic analysis: Introduction: Evolution, definition of phylogenetic tree, nodes, internodes, root, tree, styles; cladogram, phenogram, curvogram, Steps involved in construction of phylogenetic tree, Phylogenetic analysis tools: Phylip, ClustalW. **Drug designing** Structure-based drug designing: Introduction; Structure-based drug designing approaches, Target Identification and Validation, homology modeling and protein folding, receptor mapping, active site analysis and pharmacophore mapping, Grid maps. Ligand-based drug designing and Docking: Introduction; Ligand-based drug designing approaches, Lead Designing, combinatorial chemistry, High Throughput Screening (HTS),	

	QSAR, Database generation and Chemical libraries, ADME property.	

Reference Books: -

- Fundamentals of microbiology-Frobisher
- Molecular Biotechnology – Principles & applications of Recombinant DNA :Glick B. R. & Padtranak
- Gene cloning & manipulating – Christopher
- Principle of gene manipulation: An introduction to genetic engineering –Old R.W. & Primrose S. B.
- Gene VIII – Lewin
- Fundamentals of Biotechnology – S. S. Purohit
- Fundamentals of Biotechnology – H. S. Chawala
- Genetic engineering – P. K. Gupta
- Plant genetic engineering – P. K. Gupta
- Molecular Biotechnology of gene – S. N. Jogdan
- Molecular Biotechnology – Principle & practices by Channarayappa
- Biotechnology – R. C. Dubey
- Molecular cloning (Vol I, II, III) – Sambrook and Russel
- Bioinformatics methods and applications. S. C. Rastogi, N. Mendiratta, P.Rastogi.
- Principle of bioinformatics. P. Shanmughavel.
- Computational Drug Designing. David C. Young
- Computational Drug Design: A Guide for Computational and Medicinal Chemists. David C. Young
- An introduction to Bioinformatics. T. K. Attwood, Parry-Smith D. J.
- A textbook of bioinformatics. Sharma, Munjal, Shankar.

Title of course – MMT 303- Industrial Biotechnology
Course code- MSU0325MML97I3
Total credits- 4

Course Objectives:

- To make students aware of fundamentals of industrial biotechnology.
- To make the student aware of basics of fermentation process.
- To study working of downstream process and product recovery.
- To understand concepts of microbial production.

Course outcome:-: After completing the credits students should gain knowledge about:

- Fundamentals of industrial biotechnology.
- Basic concepts of fermentation technology.
- Downstream process and product recovery.
- Microbial production of various bioactive compounds.

		60 Hrs
Credit I	**Introduction to Industrial Biotechnology**	**15 Hrs**
	Introduction to Industrial Biotechnology Concept and range of fermentation technology, Types of fermentations (Batch, continuous, dual, multiple), Concept of solid state & submerged fermentation. Microbial metabolic products- Primary & Secondary products. Basic design of fermenter Components of fermenter and their functions, Fermentation economics Types of fermenter- Stirred tank fermenter, Airlift fermenter, Tower fermenter, Tubular fermenter, Bubble cap fermenter. Microbial Screening, Scale up and strain improvement Primary and secondary screening, Primary screening of antibiotics, organic acids and amines, enzymes, vitamins and amino acid producers, volatile component degraders, organisms using specific carbon and nitrogen sources. Secondary screening of antibiotic producers, Scale up of fermentations.	
Credit II	**Strain improvement and Fermentation Media**	**15 Hrs**
	Strain improvement- concept and methods -mutation, genetic recombination. Maintenance and preservation of industrially important cultures. Microbiological assay. Fermentation Media Composition of typical fermentation media, Criteria for typical fermentation medium, Types of fermentation media, General role of media components- water, carbon source, nitrogen source, minerals, precursors, growth factors, buffers, antifoams, oxidation-reduction potentials, inducers, inhibitors. Optimization of media- Plackett and Burmann design , Factors affecting fermentation process .	
Credit III	**Downstream Process and Product Recovery**	**15 Hrs**
	Downstream Process and Product Recovery Downstream Processes in fermentation and bioprocess technology Solid and liquid separation, Flocculation and Flotation, filtration and centrifugation, Cell disruption by solid and liquid shear,	

	ultrasonication, enzyme action and mechanical disruption. Product recovery and purification- principle, Precipitation, Crystallization, Liquid-Liquid extraction, Distillation (Fractional and Steam), evaporation, Chromatographic separation (Principles), Adsorption and concentration, Membrane filtration, drying and packing.	
Credit IV	**Microbial Cultures and Production**	**15 Hrs**
	Microbial Cultures and Production Concept of pure and mixed culture., Microbial growth kinetics basic concept (Batch, Continuous and Fed Batch). Microbial Production of - Enzymes (amylase –koji fermentat ion), Antibiotics (Penicillin), Vitamins (B 12), Amino acids (Lysine), Organic acid (Citric acid).	

Reference Books: -

- Text Book of Biotechnology – Dr. H. K. Das
- Industrial Microbiology & Biotechnology – Arnold L.
- Fermentation Technology – Jayanto Acharekar
- Basic Biotechnology – Colin and Bjrorn
- Frontiers in Microbial Biotechnology – Bisel P.S.
- Industrial Microbiology – Prescot and Dunn
- Principle of Fermentation Technology – Stanbury P.F ., Whitekar H., Hall S.
- Bioprocess Engineering : Principles – Nielson T. an d Villadeson J.
- Industrial Microbology- L.E. Casida
- Fermentation Biotechnology- H.A. Modi
- Industrial Microbiology- A.H.Patel

Title of course – MET 304 A- Stem Cell Technology
Course code- MSU0325MEL97I1
Total credits- 4

Course Objectives:

- To study Stem cell Technology.
- To understand the process of stem cell differentiation.

Course Outcomes: After completing the credits students should gain knowledge about:

- Exploration of stem cell technology in various fields.
- Knowledge of cancer stem cells and regulation.
- Contributions of stem cell technology in medical field.

		60 Hrs
Credit I	**Introduction and Basic Biology of Stem Cells**	**15 Hrs**
	History of stem cell research, stemness, type of stem cells, stem cell markers, types of adult stem cells- Bone marrow, adipose tissue, cord blood, placenta etc. Differentiation and transdifferentiation of stem cells, stem cell niches and regulation of stem cell niche in different adult tissues.	
Credit II	**Pluripotent stem cells and molecular mechanism of self renewal and differentiation.**	**15 Hrs**
	Pluripotent stem cells, isolation and maintenance of embryonic stem cells isolated from- mouse, humans, extracellular signaling in embryonic verses adult stem cells, induced pluripotent stem cells (iPSCs) and their characterization, telomerase and its regulation, symmetric and asymmetric division.	
Credit III	**Hematopoietic stem cells and their differentiation**	**15 Hrs**
	Bone marrow microenvironment, hematopoietic stem cell mobilization, isolation of hematopoietic stem cells, *ex vivo* expansion, characterization of hematopoietic stem cells, transcriptional regulation of hematopoietic stem cells, side population phenotypes, endothelial progenitor cells, multipotent adult progenitor cells, differentiation of stem cells in vivo and ex vivo, differentiation of hematopoietic stem cell lineages.	
Credit IV	**Cancer stem cell and their regulations**	**15 Hrs**
	Introduction to cancer, stem cell origin of cancer, cancer stem cells, isolation and characterization of cancer stem cells, pathways involved in cancer stem cells and their tumor progression, pericytes and tumor angiogenesis.	

Reference Books: -

- Khawaja H Haider (2021) Stem cells: Latest advances (1st Edition) Springer, Cham.
- Khalid Al-Anazi (2020) Update on Mesenchymal and Induced pluripotent stem cells. InTech Oen.
- Jonathan M. W. Slack (2017) The science of stem cells John Wiley and sons, Inc.
- RoberLanza (2014) Handbook of stem cells (3rd edition) Elsevier Academic Press.
- Stewart cell (2013) Stem cells Handbook (2nd edition), Human Press.

Title of course – MET 304 B- Clinical Research
Course code- MSU0325MEL97I2
Total credits- 4

Course Objectives:

- To understand the process of clinical research.
- To understand designs used in clinical research.
- To understand the study of clinical trials.
- To study the clinical data management.

Course Outcomes: After completing the credits students should gain knowledge about:

- Basic clinical research.
- Process of clinical trials.
- Monitoring visit and quality assurance.
- Data management of clinical trials.

		60 Hrs
Credit I	**Historical Perspectives and Types used in clinical research**	**15 Hrs**
	Historical Perspectives: Nuremberg Code Study, The Belmont Report, The declaration of Helsinki, Origin and Principles of International Conference on Harmonization – Good Clinical Practice (ICH-GCP) guidelines Informed Consent Process: Ethical principles governing informed consent process, Structure and content of a Patient Information Sheet Structure and content of an Informed Consent Form, The process of taking informed consent and documentation Types and Designs used in Clinical Research: Types of research designs based on Controlling Method (Experimental, Quasi experimental, and Observational methods) Randomization techniques (Simple randomization, restricted randomization, blocking method and stratification),Time Sequences (Prospective and Retrospective), Sampling methods (Cohort study, case Control study and cross sectional study), Health outcome measures (Clinical & Physiological, Humanistic and economic)	
Credit II	**Clinical Trial Study team**	**15 Hrs**
	Clinical Trial Study team: Roles and responsibilities of: Investigator, Study Coordinator, Sponsor, Monitor, Contract Research Organization, Site management Organizations. Clinical trial Documents: Guidelines to the preparation of following documents: Protocols, Investigator's Brochure, Informed Consent Form, Case report forms, Contracts and agreements, Trial Master File preparation and maintenance, Investigator Site File, Pharmacy File, Dairy Cards Clinical Trial Start up activities: Site Feasibility Studies, Site/Investigator selection, Pre-study visit, Investigator meeting, Clinical trial agreement execution, Ethics committee document preparation and submission, Site initiation visit, Investigational Product: Procurement and Storage of investigation product	
Credit III	**Monitoring visit and Quality Assurance**	**15 Hrs**
	Preparation and conduct of monitoring visit: Review of source documents, CRF, ICF, IP storage, accountability and reconciliation, Study Procedure, EC communications, Safety	

	reporting, Monitoring visit reporting and follow-up Close-Out visit: Study related documents collection, Archival requirement, Investigational Product reconciliation and destruction, Close-Out visit report. Quality Assurance and Quality Control in Clinical Trials: Audit criteria, Audit process, Responsibilities of stakeholders in audit process, Audit follow-up and documentation, Audit resolution and Preparing for FDA inspections, Fraud and misconduct management	
Credit IV	**Clinical Data Management**	**15 Hrs**
	Clinical Data Management -Infrastructure and System Requirement for Data Management: Electronic data capture systems, Selection and implementation of new systems, System validation and test procedures, Coding dictionaries, Data migration and archival Clinical Trial Data Management: Standard Operating Procedures, Data management plan, CRF & Data base design considerations, Study set-up, Data entry, CRF tracking and corrections, Central lab, IVRS, source data. Data cleaning, managing laboratory and ADR data, Data transfer and database lock, Quality Control and Quality Assurance in CDM, Data mining and warehousing	

Reference Books: -

- Handbook of clinical research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone c.
- Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes
- Recent Central Drugs Standard Control Organization. Good Clinical Practices-Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2013,2017.
- International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 1996.
- Ethical Guidelines for Biomedical Research on Human Subjects 2000, 2014, 2017. Indian Council of Medical Research, New Delhi.
- Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
- Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications Goon A. M., Gupta M. K. and Dasgupta B.: Fundamentals of mathematical statistics vol. I & II. World Press, Calcutta.

Title of course – MMPR 305- Lab Course V
Course code- MSU0325MMP97I1
Total credits- 2

Course Objectives: Upon completion of the lab course, students should be able to:

- Familiarize students with the fundamental techniques employed in recombinant DNA (rDNA) technology through hands-on laboratory experiences.
- Equip students with practical skills in utilizing bioinformatics tools, enabling them to analyze and interpret biological data effectively.
- Provide students with the necessary skills for applications in industrial biotechnology, allowing them to apply theoretical knowledge to practical scenarios in a laboratory setting.

Course outcome: Upon completing the lab course students should be able to:

- Apply Polymerase Chain Reaction (PCR) and blotting techniques proficiently in a laboratory setting.
- Utilize databases, BLAST, Clustal W, and Rasmol for effective data analysis and interpretation.
- Demonstrate the production of enzymes, antibiotics, alcohol, biofertilizers, and biopesticides, showcasing hands-on skills in industrial biotechnology applications.

Sr. No.	Name of the Practical's	Credits
1	Restriction digestion of DNA	**I**
2	Western blotting technique	
3	Southern blotting technique	
4	DNA Amplification by PCR	
5	Introduction to PUBMED Central database using the ENTREZ search engine.	
6	Getting the amino acid and gene sequences by exploring and querying the protein and nucleic acid Sequence database. Similarity search for nucleotide and protein using the BLASTn, BLASTp and interpretation of the results.	
7	Protein and nucleic acid pair-wise sequence alignment by using ClustalW and Construction of Phylogenetic Tree using ClustalW.	**II**
8	Analysis of Secondary and tertiary structure of protein using visualizing software like Pymol or Rasmol	
9	Primary screening of amylase/ antibiotic producing organism from soil	
10	Microbial production of enzyme / alcohol	
11	Isolation and production of biofertilizer/biopesticide.	

Title of course – RP 306- Research Project
Course code- MSU0325RPP97I
Total credits- 4
(60 Hrs) 100 Marks

Title of course – MMT 401 Medical Biotechnology
Course code- MSU0325MML97J1
Total credits- 4

Course Objectives:

- To make the student aware of various diseases.
- To make the student aware of process of chemotherapy.
- To make the student aware of vaccines and transgenics.
- To make the student aware of monoclonal antibodies, biosensors, gene therapy

Course Outcome: After completing the credits students should gain knowledge about:

- Types of diseases.
- Process in detail of chemotherapy.
- Concept and types of vaccines.
- Transgenic and their applications.
- Basics and applications of monoclonal antibodies, biosensors, gene therapy.

		60 Hrs
Credit I	**Study of Diseases**	**15 Hrs**
	Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission, pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by i)Mycobacterium tuberculosis ii)Clostridium perfringens iii)Treponema pallidum iv)Pseudomonas aeruginosa v)Vibrio cholera vi)Staphylococcus aureus vii)Leptospira interrogans viii)Klebsiella pneumonia Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission and pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by1) Protozoa : Plasmodium falciparum (malaria) 2) Viruses : i) Hepatitis A & B virus , ii) Rabies virus iii) Dengue virus 3) Fungus: Candida albicans.	
Credit II	**Chemotherapy**	**15 Hrs**
	Chemotherapy 1) Chemoprophylaxis 2) General principles of chemotherapy 3) Mode of action of antimicrobial agents: a) Antibacterial drugs: Penicillin, Bacitracin, Piperacillin, cycloserine, Streptomycin, Tetracycline, Trimethoprim, Sulphonamides and Quinolones . b) Antiviral drug :AZT, c) Antifungal drugs: Ketoconazole, Griseofulvin, Nystatin d) Antiprotozoal drugs: Metranidazole, Mepacrine 4) Drug resistance: Reasons and Mechanism of drug resistance.	
Credit III	**Vaccines and Transgenic technology**	**15 Hrs**
	Vaccines- Principle and Practices, Immunoprophylaxis: Vaccines and Immune Sera a) Vaccines-live attenuated, inactive, subunit, conjugate and DNA vaccines b) Immune Sera- examples with applications Concept and types of vaccine, Subunit vaccines- Hepatitis B vaccine, Foot and Mouth disease Vaccine, AIDS Vaccine, DNA Vaccines,	

	Edible Vaccines, Recombinant vaccines- Cholera Vaccine, Vaccinia Virus Vaccine.Transgenic Technology Transgenic technology & cloning in mammals, Transgenic mice and their applications, Transgenic cattle.	
Credit IV	**Monoclonal Antibodies, Biosensors, Gene therapy**	**15 Hrs**
	Monoclonal Antibodies- Introduction, Hybridoma Technology, Applications- Diagnostics , Therapeutics , Protein purification and Abzymes. Biosensors- Introduction, Principle, Types (Amperometric, Thermometric, Optical biosensor, Immuno biosensor), Applications Gene Therapy – Introduction , Approaches-ex vivo (Therapy for Adenosine deaminase deficiency) and in vivo gene therapy (Gene therapy strategy for cancer), Antigene and antisense therapy , antisense therapy for cancer Public health Introduction, DNA sample preparation, Methods of Diagnosis – Nucleic acid hybridization (Radioactive and Non radio detection). Detection of infectious disease (Tuberculosis, Malaria, AIDS, Chaga's) Detection of genetic diseases (cystic fibrosis, Sickle cell Anemia, Huntington's, DMD).	

Reference Books: -

- Microbiology–Davis B.D., Delbacco, 4th edition,1990 ,J.B.Lippincott Co. NY
- Text book of Microbiology-Ananthnarayan R and C.E. Jayaram Panikar 5th edition, 1996, Orient Longman
- Medical Bacteriology-Dey N .C. & Dey T.K. 17 th edition 1988, Allied Agency, Calcutta
- Medical Bacteriology including Medical Mycology & AIDS–T. K. Dey, D. Sinha & N. C. Dey,New Central Book Agency (Kolkata)
- Principals and Practice of Clinical Bacteriology–A.M.Emmerson
- Antimicrobial chemotherapy- David Greenwood, 5th edition, Oxford university press
- Medical Laboratory Technology;Vol. III,-Mukharjee K.L. ,10th edition. Tata Mc Graw-Hill Pub Co. Ananthnarayan and Paniker's Textbook of Microbiology –9th edition , Editor Arati Kapil 2013, University Press
- Biotechnology – U. Satyanarayana
- Medical biotechnology – S. N. Jogdand
- Advances in Biotechnology- S.N.Jogadand
- A textbook of Biotechnology - R. C. Dubey
- Pharmaceutical Biotechnology – S. P . Vyas ,V. K. Dixit
- Biotchnology – B. D. Singh

Title of course – MMT 402 Environment and Pharmaceutical Biotechnology
Course code- MSU0325MML97J2
Total credits- 4

Course Objectives:

- Develop a foundational understanding of pollution's fundamental concepts.
- Familiarize students with the processes of bioremediation and phytoremediation.
- Introduce students to various methods employed in drug discovery.
- Provide insight into the pharmacology of drugs and formulations for a comprehensive understanding.

Course Outcome: Upon successful completion of the course, students should be able to:

- Demonstrate an understanding of fundamental concepts related to air, water, and soil pollution.
- Apply specific techniques associated with bioremediation.
- Evaluate the pharmacology of drugs, formulations, and regulatory aspects.

		60 Hrs
Credit I	**Air, Water and Soil pollution**	**15 Hrs**
	Air Pollution Definition, Sources London and LA Smogs (Mechanisms of Formation) Greenhouse Effect (Concept, Reasons, Role of dipole moment of gaseous molecules) Ozone Depletion (Role of CFCs, Control) Instrumental analysis methods of SO_2,NO_x **Water Pollution** Definition,Sources and Types-Physical, Chemical and Biological Hardness -Mechanism, Determination, Types, Numericals . Water softening methods -Clark's method, Use of cation and anion exchange resins. COD and BOD -Concept, Determination Eutrophication -Concept, Types and Control. Purification of water-Physical Methos-UV Treatment, Distillation. Chemical Methods-Chlorination, Ozonization. **Soil Pollution** Definition, Sources, Role of pesticide in soil pollution, control measures. **Biodegradation, Bioconversion and Bioabsorption** Microorganisms in lignocellulose degradation, Cellulases and xylanases, Biodegradation of starch, glycogen, pullulan, dextrins and proteins. Xenobiotic compounds: chemical properties influencing biodegradability, mechanisms of degradation, microorganisms for degrading organic pollutants (petroleum products, methane/n-alkanes, alkenes, cycloaliphatic compounds). Microorganisms in metal absorption, factors affecting bioabsorption, Phytoremediation.	
Credit II	**Biotechnological Applications in Environmental Management**	**15 Hrs**
	Biotechnological Applications in Environmental Management Carbon sequestration, Bioremediation: microorganisms and techniques, Bioenergy, Bioethanol and Biodiesel, Biomethanation (Biogas from anaerobic treatment), Biofertilizers and biopesticides, Composting: process and decomposition stages, vermicomposting,	

	Biopolymers and Bioplastics, Bioleaching, Nanomaterials. **Remedial Mechanisms of Industrial Problems** Pulp and paper industry: problems associated and treatment of pollutants, Tannery industry: effluent characteristics and treatment, Ex situ bioremediation, Distillary effluent treatment, Treatment methods for dye industry effluents, Waste reduction and treatment of effluents from pharmaceutical, petroleum and dairy industries.	
Credit III	**Drug discovery methods**	**15 Hrs**
	Drug discovery methods Meaning of drugs, Drug Discovery Process, biological activity directed and other types of screening, natural products, combinatorial chemistry; General overview of validation techniques, Methods of Drug Discovery and development, QSAR and SAR. Concepts of Bio availability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy, Drug delivery considerations for the new biotherapeutics.	
Credit IV	**Pharmacology of drugs, Formulations, Regulations**	**15 Hrs**
	Pharmacology of drugs Physicochemical Properties in Relation to Biological Action, Effects of route of administration, Drug Targets, Validation techniques of Pharmaceutical targets, Pharmacokinetics and pharmacodynamics of drugs, Drug Toxicity. Basic terminologies in drug delivery and drug targeting, Doses forms, Various routes of administration of drugs (just introduction), Strategies for enhanced therapeutic efficacies (Basic principles) DNA vaccines, Vaccines & Monoclonal antibody based pharmaceuticals, Antibiotics, Characterization and Bioanalytical aspects of Recombinant proteins as pharmaceutical drugs. **Formulations** Formulation of Biotechnological Products, Drug Delivery, Examples of some Biotechnological products in clinical development. **Regulations** Role of FDA, ICH Guidelines, The Regulation of Pharmaceutical Biotechnological Products and Ethical Issues.	

Reference Books: -

- Applied and enviornmental Microbiology ; Amann, R.I Stromely, J.Stahl.
- Enviornmental Biotechnology. , Chattergy.
- Enviornmental Biology,Verma Agerwal
- Enviornmental Chemistry ,B.K Sharma.
- Enviornmental pollution, Peavy and Rowe.

- Enviornmental problems and solution., Asthana and Asthana.
- Enviornmental Chemistry Manahan.
- Enviornmental Science., Saigo, Canninhham
- Enviornmental Chemistry.,A.K.Bagi and G.R.Chatwal
- A textbook of Biotecnoiogy., R.C.Dudey.
- Drug Delivery and Targeting, A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publisher
- Pharmaceutical Dosage Forms and Drug Delivery Systems, H.C. Ansel, L.V. allen and N.G. Popovich, Lippincott Williams and Wilkins Publisher
- Applications of Targeted Nano Drugs and Delivery Systems, Shyam Mohapatra, Shivendu
- Ranjan, Nandita Dasgupta, Raghvendra Mishra and Sabu Thomas (EDs.), Elsevier, 2019.
- Introduction to Biophysical Methods for Protein and Nucleic Acid Research, J.A. Glasel and M.P. Deutscher, Academic Press.

Title of course – MMT 403 Cancer Biology and Nanotechnology
Course code- MSU0325MML97J3
Total credits- 4

Course Objectives:

- To understand the basics of cancer biology, oncogensis and signal transduction.
- To understand the natural history of cancer development, current concepts in cancer therapy.
- To understand the fundamentals of nanoscale materials, Synthesis and characterization of different nanomaterials.
- To understand the Basic structure of Nanoparticles and bionanocomposites.
- To understand the sustainable Nanobiotechnology.

Course Outcome: After completing the credits students should gain knowledge about:

- The mechanism of carcinogenesis, cancer initiation, promotion and progression, Cancer cell cycles, Tumor suppressor gene pathways, DNA methylation, epigenetic silencing of suppressor genes.
- Detection of oncogene abnormalities in clinical specimens, Cell: cell interactions, cell adhesion, angiogenesis, invasion and metastasis.
- Strategies of anticancer gene therapy.
- Different formats of nanomaterials, Cellular nanostructure and Bio-inspired Nanostructures.
- Be able to understand the Synthesis and characterization of nanomaterials.
- Be able to understand the Applications of nanobiotechnology in Plant and animal cell cultures.

		60 Hrs
Credit I	**Cancer Biology and Genes**	**15 Hrs**
	Cancer Biology: the basics Introduction, historical perspective, classification, Carcinogenesis, cancer initiation, promotion and progression, Cancer cell cycles, Genomic instability, Apoptosis, Genes and proteins as players in apoptosis, DNA viruses/ cell immortalization. **Cancer Genes : Oncogenes and signal transduction** Cellular proto-oncogenes, oncogene activation, Growth factors, growth factor receptors, signal transduction , Transcription, Transcription factors and cancer, Retroviral oncogenes, Tumor suppressor, Tumor suppressor gene pathways, DNA methylation, epigenetic silencing of suppressor genes.	
Credit II	**History of cancer development and therapy**	**15 Hrs**
	Understanding Cancer as a Disease: natural history of cancer development Free radicals, antioxidants and metabolic oxidative stress and cancer, Epidemiology of selected cancers, Gene rearrangements, detecting oncogene abnormalities in clinical specimens, Cell: cell interactions, cell adhesion, angiogenesis, invasion and metastasis, Antiangiogenic therapy of cancer. **Current concepts in cancer therapy** Strategies of anticancer chemotherapy, Strategies of anticancer gene therapy/translating therapies from the laboratory to the clinic, Gene discovery in cancer research, cancer genome anatomy project , Cancer immunity and strategies of anticancer immunotherapy, stem cells and their applications in cancer	

	therapy.	
Credit III	**Nanobiotechnology**	**15 Hrs**
	Introduction and Fundamentals of nanobiotechnology Concepts, historical perspective; Nanoscale materials: Definition and properties; Different formats of nanomaterial and applications; Cellular nanostructure; nanopores; Biomolecular motors; Bio-inspired Nanostructures, Quantum dots. **Synthesis and characterization of different nanomaterials**: Synthesis of nanomaterials from plant, microbial and animal cell sources. Characterization of nanomaterials using Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, Thermogravimetric Analysis, Differential Scanning Calorimetry, Thermomechanical Analysis, X-Ray, neutron diffraction.	
Credit IV	**Nano-particles and their Applications**	**15 Hrs**
	Nano-particles **Concepts of Nanoparticles**: Basic structure of Nanoparticles- Kinetics in nano-structured Materials- Zero dimensional, size and shape of nanoparticles; one-dimensional and two-dimensional nanostructures; clusters of metals and semiconductors, bionano-particles. **Synthesis of Nanoparticles**- Physical, Chemical and Biological. **Applications of Nanobiotechnology** **Applications of Nanomedicine:** Nanotechnology in diagnostic applications, materials used in Diagnostics and Therapeutics. Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nano-scaffolds in synthesis, applications of nano-biocatalysis in the production of drugs and drug intermediates. **Nano-films:** Thin films; Colloidal nanostructures; Self-assembly, Nanovesicles; Nanospheres; nanocapsules and their characterization. **Nanoparticles for drug delivery**: Strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers. **Nanoparticles for diagnostics and imaging:** Concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. **Applications in Agriculture:** Biogenic nanomaterials and their role in soil, water quality and plant protection; Smart nanoscale systems for targeted delivery of fertilizers, pesticides (nanocides); Nanoremediation.	

Reference Books: -

- Molecular Biology of the Cell. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. 2008. (5th Ed.) New York: Garland Science.
- Molecular Cell Biology . Lodish, H. F. 2016 (8th Ed.). New York: W.H. Freeman.
- The Cell: a Molecular Approach. Cooper, G. M., & Hausman, R. E. (2013). (6th Ed.). Washington: ASM; Sunderland.

- Becker's World of the Cell. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Boston (8th Ed.). Benjamin Cummings.
- Molecular Biology of the Gene . Watson, J. D. (2008). (5th ed.). Menlo Park, CA: Benjamin/Cummings.
- Kuby Immunology. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). New York: W.H. Freeman.
- New Generation Vaccines. Levine, M. M. (2004). New York: M. Dekker.
- Bharat Bhushan: .Handbook of Nanotechnology, Springer
- Jurgen Schulte: Nanotechnology: Global Strategies, Industry Trends and Applications
- Luisa Filipponi and Duncan Sutherland: Nanotechnologies: principles, applications, implications and hands on activities
- Nanomaterials – An introduction to synthesis, properties and applications, D. Vollath, WileyVCH, Second Edition 2013
- Nanostructured materials: Processing, Properties and Potential Applications, Edited by Carl. C. Koch, Noyes Publications, 2002

Title of course – MET 404 A Food and Agricultural Biotechnology
Course code- MSU0325MEL97J1
Total credits- 4

Course Objectives:

- To understand the fermentation of foods, milk, fish and food authentication.
- To understand the production of functional foods, designer foods, neutraceuticals, GM foods.
- To study the basics of Plant tissue culture, Micropropagation, Plant transformation and Genetic manipulation of plants.
- To understand the application of Plant tissue culture, commercial product development.

Course Outcome: After completing the credits students should gain knowledge about:

- Production of tempeh, soy sauce, rice wine and anticancer compounds infoods.
- Biochemical processing in the improvement of functional foods with targeted health benefits and increased nutrient value.
- Plant micropropagation, germplasm preservation, haploid production and direct gene transfer techniques.
- Production of secondary metabolites from plants, molecular farming and mushroom cultivation.

		60 Hrs
Credit I	**Food Biotechnology I**	**15 Hrs**
	Introduction to Food biotechnology, Fermented foods, milk-based products, fermented vegetables, fermented meats, fish, beverages, vinegar, mould fermentation - tempeh, soysauce, rice wine. Enzymatic processing of fruit juices; DNA-based methods for food authentication, comparative methods of toxicity testing in (novel) foods, application of generic technologies in food and nutritional sciences; anti-cancer components in foods.	
Credit II	**Food Biotechnology II**	**15 Hrs**
	Functional foods and Biotechnology: Biochemical processing in the improvement of functional foods with targeted health benefits and increased nutrient value; Pre- and Pro-biotics, single cell protein, single cell lipids. Manipulation of fruit ripening process. Food processing, principles and practices, food ingredients and processing aids from biotechnological processes, corn sweeteners, bacterial starter cultures, cold-adapted enzymes. Food spoilage, preservation, mycotoxins in food commodities. Genetically modified foods, designer foods, detection of GM foods, Nutraceuticals, Concept of food parks.	
Credit III	**Agricultural Biotechnology I**	**15 Hrs**
	Biofertilizers – Definition ,Principle , Mass production and field application – Rhizobium,Azotobacter,Azospirillum,Acetobacter,Azolla, Cyanobacteria, PSB, VAM. Biopesticide – Definition, production and applications of Bacterial, fungal, viral and Plant origin Biopesticides. Biotechnology for crop improvement – Role of Somaclonal variations, Haploids, Micropropagation, Somatic embryogenesis in	

	crop improvement. Somatic hybridization- Definition, protoplast, fusion technique, selection of hybrids, symmetric and asymmetric hybrids, cybrid production. Artificial Seed- Definition, Techniques, factors affecting, applications limitations. Germplasm Conservation- Introduction, In-situ conservation, Exsitu conservation, cryopreservation, Techniques of Cryopreservation, applications, limitations.	
Credit IV	**Agricultural Biotechnology II**	**15 Hrs**
	Transgenic Plants Herbicide resistant – Glyphosate resistance, Pho sphinothricin resistance, Fungal and Bacterial disease resistance approaches- PR proteins, Chitinase, Glucanase, RIPs protein, Virus resistance – Virus coat proteins, Movement proteins ,Trasmission proteins ,Satellite RNAs, Antisense RNAs, Ribozymes, Insect resistance approaches – Bt protein (Bt Cotton, Bt-Brijal) , Non Bt protein, Transgenic plant with improved nutrition - Golden Rice, Molecular farming.	

Reference Books: -

- Text Book of Biotechnology – Dr. H. K. Das
- Industrial Microbiology & Biotechnology – Arnold L.
- Fermentation Technology – Jayanto Acharekar
- Basic Biotechnology – Colin and Bjrorn Frontiers in Microbial Biotechnology – Bisel P.S.
- Industrial Microbiology – Prescot and Dunn
- Principle of Fermentation Technology – Stanbury P.F ., Whitekar H., Hall S. J.
- Bioprocess Engineering : Principles – Nielson T. an d Villadeson J.
- Industrial Microbology- L.E. Casida
- Fermentation Biotechnology- H.A. Modi
- Industrial Microbiology- A.H.Patel
- Food Biotechnology- Varun Mehta
- Biotechnology – U. Satyanarayana
- A textbook of plant breeding – B.D . Singh
- Medical biotechnology – S. N. Jogd and
- Advances in Biotechnology- S.N.Jogadand
- Introduction to plant breeding – R . C. Chaudhary
- A textbook of Biotechnology - R. C. Dubey
- Pharmaceutical Biotechnology – S. P . Vyas ,V. K. Dixit
- Biotchnology – B. D. Singh
- Fundamentals of agriculture biotechnology – S . S. Purohit
- Animal & cell biotechnology – Ian, Freshney
- Animal cell biotechnology – Buttler
- Methods in cell biology – Volume 5 7
- Cell and Developmental Biotechnology.-Raj narian Desikar
- Agricultutre application of Microbiology- Neeelima Rajvaidya.

Title of course – MET 404 B Industrial Waste Management
Course code- MSU0325MEL97J2
Total credits- 4

Course Objectives:

- To understand the basics of industrial waste management.
- To understand the methods of industrial waste treatment.
- To understand the fundamentals of biomanagement of industrial waste.

Course Outcome: After completing the credits students should gain knowledge about:

- Different processes, types, characterization of industrial waste.
- Microbiology and biochemistry of waste water treatment.
- Biomanagement of industrial waste.

		60 Hrs
Credit I	**Types and Characterization of industrial wastes**	**15 Hrs**
	Types of industrial wastes General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD, BOD and organic carbon Effects of industrial wastes on aquatic life- Effects of industrial wastes of high BOD, effects of waste with toxicants Self purification in natural waters: Introduction, physical process, chemical process, biological process.	
Credit II	**Microbiology and biochemistry of wastewater treatment I**	**15 Hrs**
	Introduction, Cell physiology and important microorganisms – important microorganisms, role of enzymes, principles of growth, plasmid borne metabolic activities Impact of pollutants on biotreatment Methods of industrial waste treatment: Part-I:- Physico-chemical Methods - neutralization, oxidation of cyanides, Chromium reduction, reverse osmosis, carbon adsorption, destruction of phenolic compounds	
Credit III	**Microbiology and biochemistry of wastewater treatment II**	**15 Hrs**
	Methods of industrial waste treatment: Part-II:- Biological methods - I Activated sludge process- Process, microbiology, sludge bulking Trickling filters- Process, Microbiology and applications Methods of industrial waste treatment: Part-III:- Biological methods - II Lagooning- Aerobic and anaerobic, applications Anaerobic digestion- Process, microbiology of bio-gas formation, applications	
Credit IV	**Biomanagement of industrial waste**	**15 Hrs**
	Biomanagement of industrial waste: technological options for treatment of liquid and solid wastes– bioaugmentation, packaged microorganisms, use of genetically engineered microorganisms in wastewater treatment Industrial waste treatment: methods of treatment of wastes from Dairies, Distilleries, paper and pulp industries, fertilizer industries and Pharmaceutical industries. Zero waste discharge concept in industries. Waste disposal control and regulations: Water pollution control,	

	Regulation and limits for disposal into lakes, rivers, oceans and land.	

Reference books

- Industrial Pollution Control Vol. - I by E. J. Middlebrooks
- The treatment of industrial wastes. (2nd ed) by E. B. Besselievre and M. Schwartz
- Environmental Biotechnology (Industrial pollution management) by S. N. Jogdand, Himalaya Publishing House
- Water and water pollution Handbook Vol. – I by Leonard L. Ciaccio
- Wastewater Treatment by M.N. Rao and A. K. Datta
- Industrial Pollution by N. L. Sax. Van Nostrand Reinhold Company
- Encyclopaedia of Environmental Science and Technology Vol. – II by Ram Kumar
- Water Pollution Microbiology by R. Mitchell
- Handbook of Water Resources and Pollution Control by H.W. Gehm and J. I. Bregman
- Environmental Microbiology by P. D. Sharma, Narosa Publishing House, New Delhi.

Title of course – MET 404 C Quality Assurance and Validation
Course code- MSU0325MEL97J3
Total credits- 4

Course Objectives:

- To understand the basics of Pharmaceutical Drug Regulatory Affairs.
- To understand clean room standards and environmental monitoring.
- To understand the fundamentals of bioburden determination.
- To understand the Basic structure of pharmaceutical quality system

Course Outcome: After completing the credits students should gain knowledge about:

- Process of pharmaceutical drug regulatory affairs.
- Clean room standards and environmental monitoring.
- Bioburden determination and Quality management systems in pharmaceutical manufacturing.

		60 Hrs
Credit I	**Pharmaceutical Drug Regulatory Affairs**	**15 Hrs**
	Pharmaceutical Drug Regulatory Affairs– Introduction to Regulatory Affairs; Drug Regulatory bodies - United States Food and Drug Administration (USFDA); International Conference on Harmonization of technical Requirement for registration of Pharmaceuticals for Human use (ICH); European Medicines Agency (EMA); Central Drugs Standard Control Organization (CDSCO); Medicines and Healthcare Products Regulatory Agency (MHRA).	
Credit II	**Cleanrooms and environmental monitoring**	**15 Hrs**
	Cleanrooms and environmental monitoring - Introduction; Cleanroom contamination; Cleanroom classification; Isolators; Cleanroom certification; HEPPA and ULPA filters; Cleanroom testing; Microbiological environmental monitoring- Monitoring of air born viable particles, surface monitoring, water monitoring; Aseptic technique; Other cleanroom disciplines; Cleanroom standards,	
Credit III	**Bioburden determination**	**15 Hrs**
	Bioburden determination – Introduction; Total microbial count - Traditional counting Methods, Detection of objectionable organisms, Nonsterile products and microbial limits testing; In-process material bioburden assessment; Pre-sterilization bioburden assessment; Alternative methods of bioburden assessment; Microbiological analysis of raw materials and finished products – Microbial count limits for finished products; Endotoxin and pyrogen testing - Introduction; Pyrogenicity; Bacterial endotoxin; Quantifying endotoxin; The limulus amoebocyte lysate test - methods , applications , interference;Alternative test methods.	
Credit IV	**Quality Management Systems in Pharmaceutical Manufacturing**	**15 Hrs**

	Introduction; Pharmaceutical Quality System; Good Manufacturing procedures – Specifications, Batch Manufacturing records, Standard Operating Procedures; Validation- Validation-validation master plan, Qualifications and its types, GMP Inspections; Hazard Analysis and Critical Control Point (HACCP) - Definition, Principles and Guidelines for application of HACCP principles. Auditing the microbiology laboratory- Introduction; Record keeping – Batch Manufacturing Record; Quality audits; Auditors and the audit process; Auditing the microbiology laboratory.	

Reference books

- Geoff Hanlon and Norman Hodges - Essential Microbiology for Pharmacy and
- Pharmaceutical Science, John Wiley & Sons, Ltd.
- Tim Sandle - Pharmaceutical Microbiology - Essentials for Quality Assurance and Quality Control, Woodhead Publishing publications, Elsevier.
- Laboratory biosafety manual. – 3rd ed. WHO Library Cataloguing-in-Publication Data ISBN 9241546506.
- Environmental Monitoring for cleanrooms and Controlled environments by Anne Marie
- Dixon, Informa Healthcare Newyork, London, ISBN 13;978-0-8247-2359-0.
- Cleanroom Microbiology for the non-Microbiologists, Second Ed, by Devid M. Carlbarg,
- CRC Press,USA.

Title of course – RP 405- Research Project
Course code- MSU0325RPP97J
Total credits- 6
(90 Hrs) 150 Marks

8. Scheme of Teaching

Each theory paper have 4 lectures per week of 60 minute.

The practical's and research project will be conducted 3 hours per day for five days.

Seminar will be conducted for 2 hours per week.

There should be at least 15 weeks of actual teaching in each semester as per the UGC requirement.

The department should prepare academic calendar of teaching lecture hours.

Workload is as per UGC & State Govt. norms.

9. Examination Pattern

- The standard of passing Examination Ordinances and Rules will be applicable as per the existing system.
- The examination will be conducted as per the rules and regulations of Shivaji University which are applicable at that time.

A) Theory:-

- There shall be 100 marks for each course (paper). For each course 80:20 pattern shall be applicable, wherein 80 marks shall be for University Assessment (UA) (Time duration: 3 hrs.) and 20 marks for internal assessment (IA).
- There shall be separate passing for theory as well as internal examinations. Minimum 32 marks out of 80 required for passing UA and minimum 8 marks out of 20 required for passing
- The total marks for each semester examination is shall be 550.

B) Internal Assessment:-

- As per UGC guidelines there shall be continuous internal assessment for M.Sc. Programme.
- Internal Examination will be compulsory for all students. If a student fails/remains absent in internal Examination then he / she will have to clear the internal Examination in subsequent attempt/s.
- The internal examination of 20 Marks shall be conducted at the mid of the each semester. The nature of questions shall be MCQ / true / false /one sentence answer type question/ short answer type questions (Time duration: 30 minutes).

C) Practical Examination: -

- A practical exam will be conducted after theory exam.
- The core course practical (CCPR) examination shall be conducted semester wise with individual heads of passing with minimum 40% marks.
- The rules for practical examinations shall be as per respective BOS guidelines.

D) Research Project Evaluation:-

RP- 306: Research Project (4 Cr)

and

RP- 405: Research Project (6 Cr)

As per the guidelines of BOS.

10. Nature of Question Paper: Total Marks: 80

a) University Theory Examination: Skeleton of theory question paper:

M.Sc. Part – II/Sem. – III Examination – 2024 (NEP - 2023)

Biotechnology

Title of the Subject

(Subject Code)

Day & Date: **Total Marks: 80**

Time:

Instructions: 1) Question No. 1 is COMPULSORY.
2) All questions carry EQUAL marks.
3) Solve any FOUR questions such that at least TWO questions must be from EACH section.

Instructions:
1) Question No. 1 is **COMPULSORY**.

2) All questions carry **EQUAL** marks.

3) Solve any **FOUR** questions such that at least **TWO** questions must be from **EACH** section.

Q. 1 Objective (16 Marks) 16 one line answer type questions

SECTION-I

Q.2 Essay type question (16 Marks)

Q.3 Essay type question (16 Marks)

Q.4 Essay type question (16 Marks)

SECTION-II

Q.5 Write notes on (2 x 08 Marks) 2 sub-questions

Q.6 Write short notes on (4 x 04 Marks) 4 sub-questions

Q.7 Write short notes on (4 x 04 Marks) 4 sub-questions

b) Internal Theory Examination:

The internal theory examination of 20 marks will be conducted by the Teacher in-charge of the respective subject during the semester. The internal examination theory will have 10/20 questions of 2/1 mark each. The internal theory paper will be solved on the same question paper. Separate answer book will not be given. The examination time will be 30 mins. The internal theory marks will be submitted or uploaded in the

university examination portal as per the instructions given by the examination section of the university.

c) University Practical Examination:

The university practical examination will be conducted in the department immediately after the theory examinations. The duration of practical examination will be 4 days including inspection day. The examination for both practical papers will be conducted simultaneously. The day, date, nature of question paper, marks distribution and internal/external examiners will be decided by theory examination Chairman in consultation with practical paper in charge and laboratory staff. Separate sanction/approval will be required from examination section for practical examination time-table.

11. Equivalence of courses

Equivalency is not applicable for this course because this is newly started course implemented from academic year (2024-25).