### University of Mumbai

<u>वेबसाईट</u> – mu.ac.in <u>इमिल</u> - आयडी - <u>dr.aams:@fort.mu.ac.in</u> aams3:@mu.ac.in



विद्याविषयक प्राधिकरणे सभा आणि सेवा विभाग(ए.ए.एम.एस) रूम नं. १२८ एम.जी.रोड, फोर्ट, मुंबई - ४०० ०३२ टेलिफोन नं - ०२२ - ६८३२००३३

(नॅक पुनमूल्यांकनाद्वारे ३.६५ (सी.जी.पी.ए.) सह अ++ श्रेणी विद्यापीठ अनुदान आयोगाद्वारे श्रेणी १ विद्यापीठ दर्जा)

क.वि.प्रा.स.से./आयसीडी/२०२५-२६/३७

दिनांक : २७ मे, २०२५

प्रसाद कारंडे

परिपत्रक:-

सर्व प्राचार्य/संचालक, संलग्नित महाविद्यालये/संस्था, विद्यापीठ शैक्षणिक विभागांचे संचालक/ विभाग प्रमुख यांना कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण २०२० च्या अमंलबजावणीच्या अनुषंगाने शैक्षणिक वर्ष २०२५-२६ पासून पदवी व पदव्युत्तर अभ्यासकम विद्यापरिषदेच्या दिनांक २८ मार्च २०२५ व २० मे, २०२५ च्या बैठकीमध्ये मंजूर झालेले सर्व अभ्यासकम मुंबई विद्यापीठाच्या www.mu.ac.in या संकेत स्थळावर NEP २०२० या टॅब वर उपलब्ध करण्यात आलेले आहेत.

मुंबई - ४०० ०३२ २७ मे, २०२५

क वि प्रा.स.से वि/आयसीडी/२०२५-२६/३७ दिनांक : २७ मे, २०२५ Desktop/ Pritam Loke/Marathi Circular/NEP Tab Circular



Сор	y forwarded for information and necessary action to :-
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), <u>dr@eligi.mu.ac.in</u>
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari <u>cap.exam@mu.ac.in</u>
6	The Deputy Registrar, College Affiliations & Development Department (CAD), <u>deputyregistrar.uni@gmail.com</u>
7	The Deputy Registrar, PRO, Fort, (Publication Section), <u>Pro@mu.ac.in</u>
8	The Deputy Registrar, Executive Authorities Section (EA) <u>eau120@fort.mu.ac.in</u>
	He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), <u>rapc@mu.ac.in</u>
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in <u>ar.tau@fort.mu.ac.in</u>
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, <u>thanesubcampus@mu.ac.in</u>
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentar@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, <u>director@idol.mu.ac.in</u>
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), dlleuniversityofmumbai@gmail.com

Cop	y for information :-
1	P.A to Hon'ble Vice-Chancellor,
	vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor
	pvc@fort.mu.ac.in
3	P.A to Registrar,
	registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O),
	camu@accounts.mu.ac.in

### To,

1	The Chairman, Board of Deans
	<u>pvc@fort.mu.ac.in</u>
2	Faculty of Humanities,
	Offg. Dean
	1. Prof.Anil Singh
	Dranilsingh129@gmail.com
	Offg. Associate Dean
	2. Prof.Manisha Karne
	mkarne@economics.mu.ac.in
	3 Dr Suchitra Naik
	Naiksuchitra 27@gmail.com
	Faculty of Commerce & Management,
	Offg. Dean,
	1 Prin.Ravindra Bambardekar
	principal@model-college.edu.in
	Offg. Associate Dean
	2. Dr.Kavita Laghate
	kavitalaghate@jbims.mu.ac.in
	3. Dr.Ravikant Balkrishna Sangurde
	Ravikant.s.@somaiya.edu
	4. Prin.Kishori Bhagat
	kishoribhagat@rediffmail.com

	Faculty of Science & Technology					
	Offg. Dean 1. Prof. Shivram Garje <u>ssgarje@chem.mu.ac.in</u>					
	Offg. Associate Dean					
	2. Dr. Madhav R. Rajwade <u>Madhavr64@gmail.com</u>					
	3. Prin. Deven Shah <u>sir.deven@gmail.com</u>					
	Faculty of Inter-Disciplinary Studies, Offg. Dean					
	1.Dr. Anil K. Singh <u>aksingh@trcl.org.in</u>					
	Offg. Associate Dean					
	2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com					
	3. Dr. Kunal Ingle <u>drkunalingle@gmail.com</u>					
3	Chairman, Board of Studies,					
4	The Director, Board of Examinations and Evaluation, <u>dboee@exam.mu.ac.in</u>					
5	The Director, Board of Students Development,         dsd@mu.ac.in       DSW       direcotr@dsw.mu.ac.in					
6	The Director, Department of Information & Communication Technology, director.dict@mu.ac.in					

AC -28/03/2025 Item No. - 6.11(N)

### As Per NEP 2020

### Aniversity of Mumbai



### Syllabus for Major

Vertical – 1 & 4

Name of the Programme – B.Sc. (BIOTECHNOLOGY)

Faulty of SCIENCE

Board of Studies in BIOTECHNOLOGY

U.G. Second Year Programme	Exit	U.G. Diploma in
	Degree	Biotechnology
Semester		III & IV
From the Academic Year		2025-26

### **University of Mumbai**



### (As per NEP 2020)

Sr.	Heading	Particulars
1	Title of program	B.Sc. (Biotechnology)
	0:	
2	Exit Degree	U.G. Diploma in Biotechnology
3	Scheme of Examination R:	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	Standards of Passing R:	40%
5	Credit Structure R. SU-505C R. SU-505D	Attached herewith
6	Semesters	Sem. III & IV
7	Program Academic Level	5.00
8	Pattern	Semester
9	Status	New
10	To be implemented from Academic Year	2025-26

Sd/-Sign of the BOS Chairman Dr. Varsha Kelkar-Mane BOS Chairperson in Biotechnology Sd/-

Sign of the Offg. Associate Dean Dr. Madhav R. Rajwade Faculty of Science & Technology Sd/-Sign of the Offg. Dean Prof. Shivram S. Garje Faculty of Science & Technology

### Introduction

Biotechnology is a multidisciplinary subject that deals with the application of biological processes for solving problems and designing eco-friendly products and processes. At Undergraduate level, learners are offered various subjects that would strengthen their fundamentals in basic sciences as well as explore the fundamentals as well as applications of biotechnology. Subjects such as Chemistry, Biology and Information Technology, computer language form an integral part of the syllabus. Biotechnology plays a key role in industries such refining. environmental remediation. agriculture and food as production. healthcare. pharmacy. animal husbandry. and nutrition. textiles. Learners after completing their biotechnology course can find suitable employment in the research and development laboratories, pharmaceutical companies etc. The syllabus herein discusses the subjects offered at undergraduate level highlighting the respective course as well as program outcomes

### Aims and Objectives:

The course aims at empowering the learners with a strong knowledge base of fundamental sciences, as well as applied sciences that would be useful in process development in various sectors of Biotechnology. On completion of the course the learner will be skilled and equipped with contemporary knowledge in Biotechnology and would be eligible for jobs in varied industrial sectors.

### **Learning Outcomes**

The Undergraduate program in Biotechnology has been designed on learning outcome-based curriculum framework. The course covers the areas of Biotechnology along with fundamental Sciences with a range of core subjects in each semester. Along with providing the requisite biotechnology knowledge, the course has enough scope for inter- and multidisciplinary subjects in the form of electives. This course also caters the skill enhancement needs of the learners as well as provides opportunities for exchanges and learning from other disciplines. Every semester has a practical course for strengthening skills in designing and conducting experiments in the field of Biotechnology.

### Under Graduate Diploma in Biotechnology

Credit Structure (Sem. III & IV)

### R. SU-505C

L		Major		Minor	OE	VSC,	AEC	OJT,	Cum	Deg
e v	Sem ester	Mandatory	Ele			SEC (VSF	IKS	FP, CFP	Cr./S em	ree /Cu
e	00101		ctiv es			C)		CC,	0111	m
1 5 0		8(4T+4P) Course I - (2 Credits) 2 modules Immunolog y Course II- (2 Credits) 2 modules Molecular biology II Practical I (2 Credits) Practicals in Immunolog y Practical II (2 Credits) Practical Sin Molecular Biology II		4 Credits To be taken from University Minor basket	2 Credits To be taken from University OE basket	VSC:2, Introduct ion to Bioinfor matics (Practic al based)		RP FP:2 (BT) CC:2	22	UG Dipl oma 88

R. 3	SU-505	D							
	IV	8 (4T+4P) Course III- (2 Credits) 2 modules Biochemis try Course IV- (2 Credits) 2 modules Medical Biotechno logy	4 Credits To be taken from University Minor basket	2 Credits To be taken from University OE basket	SEC:2 Microbi al laborato ry techniq ues		CEP : 2 (BT) CC:2	22	
		Course III Practicals in Biochemist ry (2 Credits) and Course IV Practicals in Medical Biotechnol ogy(2 Credits)							
	Cu m Cr.	28		10	12	6+ 6	8+4+ 2	8+4	88
Ex co	kit optio bre NS	on; Award of UG D QF course/ Interns	Diploma in Major ar	nd Minor with a with Major and	80-88 credit I Minor	s and a	an additi	onal 4 cr	edits

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Community Engagement Project, CC – Co-Curricular, RP – Research Project ]

### S.Y.B.Sc. Biotechnology (USBT) Course Structure

### Semester III

Ladder	Course Type	Title of the paper	Credits	Hours
Major 1	Theory	Immunology	2	30
Major 2	Theory	Molecular biology II	2	30
Major 3	Practical	Practical I- Immunology	2	60
Major 4	Practical	Practical II- Molecular biology II	2	60
VSC	Practical	Bioinformatics	2	60

### Semester IV

Ladder	Course Type	Title of the paper	Credits	Hours
Major 1	Theory	Biochemistry	2	30
Major 2	Theory	Medical Biotechnology	2	30
Major 3	Practical	Practical I- Biochemistry	2	60
Major 4	Practical	Practical II- Medical Biotechnology	2	60
SEC	Practical	Microbial laboratory techniques	2	60

## Sem - III

# Vertical – 1 Major

### Major

### Course I

### Title of Paper: Immunology

Sr. No.	Heading	Particulars					
1	Description the course: Including but not limited to:	This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. A description of cells involved in the immune response either innate or acquired, organs of the immune system and specific responses. Other topics covered will include the basis and types of immune reactions.					
2	Vertical:	Major					
3	Туре:	Theory					
4	Credits:	2 credits					
5	Hours Allotted:	30 Hours					
6	Marks Allotted:	50 Marks					
7	Course Objectives (CO) CO1: To promote critical immune system works. CO2: To provide students CO3: To provide students building on their knowled microbiology. CO4: To clearly state the CO5: To understand the t	: It thinking among students and understand how the with a foundation in concepts related to immunology. s with knowledge on how the immune system works, ge from biochemistry, genetics, cell biology and role of the immune system. ypes of Antigen-Antibody interactions					
8	Course Outcomes (OC): Learner will be able to: OC1: Explain the immuno OC2: Discuss the concep OC3: Diagrammatically de immune system. OC4: Explain the significa B, NK and DC, Phagocyt OC5: Discuss the types o antigen OC6: Explain the features OC7: Compare and contra	logical terms. ts of antigen and antibody. epict with appropriate labels the organs of the human ince of cells of immune system- Granulocytic cells, T , ic cells, Mast cells, NKT and FDCs f antigen antibody interactions based on nature of s of antibody structure using a labelled diagram ast: five classes of Ig					

### Module 1: Introduction to cells and organs of immune system Cells of Immune system Lymphoid cells - B lymphocytes, T Lymphocytes and NK cells. Subclasses of T cells: T helper cell (T<sub>H</sub>), T cytotoxic cell (T<sub>C</sub>), Cytotoxic T Lymphocyte (CTLs), T regulatory (Treg). Antibody Dependent Cell Cytotoxicity. • Natural Killer T (NKT) cells, Mononuclear phagocytes, Phagocytosis Granulocytic cells, Mast cells. • Dendritic cells (DC), Follicular Dendritic cells (FDC). Organs of Immune system • Primary Lymphoid organs- Thymus, Bone marrow Lymphoid Tissue (GALT). (1 lecture) (1 lecture) • Herd Immunity. (1 lecture) Introduction and definition of antigen. Factors governing antigenicity. • Types of Antigens - Intracellular, extracellular and auto antigens. • Complete and incomplete antigens, hapten, superantigens. • Concept of: epitopes, adjuvants. (4 lectures) (4 lectures) (7 lectures) • General features of Ag-Ab reactions- Prozone, Post zone, Zone of Equivalence. Types of Antigen Antibody reactions

- Precipitation Ouchterlony, SRID, Immunoelectrophoresis, Rocket Electrophoresis.
- Agglutination Blood grouping and WIDAL.
- Complement fixation tests.

(8 lectures)

- Lymphatic system.
- Secondary Lymphoid organs- Lymph nodes, Spleen.
- An introduction to Lymphoid tissue- Mucosa Associated Lymphoid Tissue (MALT), Bronchus Associated Lymphoid Tissue (BALT), Gut Associated (4 lectures)

### Immunity:

9

Modules: -

	•
•	Innate Immunity VS Adaptive Immunity.
-	Active VC Dessive immunity

- Active VS Passive immunity.

### Module 2: Antigen Antibody interactions

### Antigens:

### Antibodies:

- Definition, Discovery and Basic structure of Immunoglobulins (Ig).
- Classes of Igs & Biological functions
- Concept of: Antigenic determinants on Ig.
- Immunoglobulin superfamily.

### **Antigen - Antibody Reactions**

	<ul> <li>Coomb's test</li> <li>An introduction to types of ELIS</li> </ul>	SA- Direct, Indirect, Sandwich, Competitive
10	Text Book- —	
11	<ul> <li>Reference Books</li> <li>1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.</li> <li>2. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.</li> <li>3. Ananthanarayan and Paniker's Textbook of Microbiology, Eleventh Edition</li> <li>4. Rao C. V. (2007). Immunology. 2<sup>nd</sup> Edition. Narosa Publishing House Pvt. Ltd.</li> <li>5. Pathak S. and Palan U. (2005) Immunology: Essential and Fundamental. Science Publishers, U.S.; 2nd Revised edition edition (1 February 2005) ISBN- 10:1578083796; ISBN-13:97857883794</li> <li>6. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.</li> <li>7. Parham, P. (2005). The Immune System. New York: Garland Science.</li> </ul>	
12	Internal Continuous Assessment: 40%	Semester End Examination: 60% (Refer format of Question paper Below)
13	<b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.( at least 3 )	

### Course II Title of the paper: Molecular biology II

Sr.No.	Heading	Particulars
1	Description the course: Including but Not limited to:	This molecular biology course provides a comprehensive exploration of transcription and translation mechanisms. This course provides an indepth analysis of how genetic information is decoded, synthesized, and transformed into functional proteins across prokaryotic and eukaryotic systems.
2	Vertical :	Major
3	Туре :	Theory
4	Credits :	2 credits
5	Hours Allotted :	30 Hours
6	Marks Allotted:	50 Marks
7	<ul> <li>Course Objectives(CO):</li> <li>CO1. To develop an understanding of molecular mechanisms underlying gene expression and regulation.</li> <li>CO2. To explain the mechanisms of transcription in prokaryotic and eukaryotic organisms.</li> <li>CO3. To explore the processes of protein translation and translational regulation.</li> <li>CO4. To develop student's skills in understanding complex molecular biological mechanisms.</li> </ul>	
8	<ul> <li>Course Outcomes (OC): Learner will be able to:</li> <li>OC1: Outline the flow of genetic information from DNA to RNA to proteins.</li> <li>OC2: Explain the molecular events of transcription in prokaryotes and eukaryotes.</li> <li>OC3: Explain characteristics of genetic code.</li> <li>OC4: Describe the detailed process of protein synthesis.</li> <li>OC5: Analyze basic regulatory mechanisms controlling gene expression.</li> </ul>	
9	Modules: - Module 1: Transcription	
	<ul> <li>Transcription in Prokalectures)</li> <li>Components of prokalectures</li> <li>Initiation of Transcrisequences.</li> <li>Action of RNA polymatic Elongation of an RNA</li> </ul>	aryotic transcription unit. iption at Promoters - Role of promoter, consensus nerase in initiation and elongation A Chain.

	<ul> <li>Termination of an RNA Chair termination.</li> </ul>	n - Rho-dependent and Rho-independent
	<ul> <li>Transcription in Eukaryotes:</li> <li>lectures)</li> <li>Components of eukaryotic trans</li> <li>Eukaryotic RNA Polymerases - and Enhancers.</li> <li>Assembly of transcription initiat</li> <li>Structure and Production of Eul</li> <li>Eukaryotic mRNA processing, S</li> <li>RNA editing.</li> </ul>	(9 scription unit. types and functions, Eukaryotic Promoters ion machinery. karyotic mRNAs. Spliceosomes.
	Module 2: Translation	
	Nature of Genetic Code - Charac lectures)	teristics, ORF, Wobble Hypothesis. (2
	Role of different types of RNA in translation.(1 lecture)Charging of tRNA.(1 lecture)Translation in Prokaryotes and Eukaryotes - Process of Protein Synthesis(Initiation, Elongation, Translocation, Termination); Polyribosomes.(7lectures)Protein sorting - Signal hypothesis, effect of overlapping genes.(2 lectures)Post Translational Modifications.(2 lectures)	
	<ul> <li>Text Books</li> <li>iGenetics- molecular approapg no. 81-101</li> <li>iGenetics- molecular approapg no. 102-123</li> </ul>	ach - Peter Russell -3rd Edition Chapter 5 ach - Peter Russell -3rd Edition Chapter 6
11	<ul> <li>Reference Books</li> <li>Cell and Molecular Biology, De Robertis, Lippincott Williams&amp; Wilkins</li> <li>Karp's Cell and Molecular Biology: Concepts and Experiments—Karp – Wiley International</li> <li>Molecular Biology of the Cell, Bruce Alberts, Garland Science, Taylor &amp; Francis group</li> <li>Molecular Cell Biology, Lodish, W.H.Freeman &amp; Co Ltd</li> </ul>	
12	Internal Continuous Assessment: 40%	Semester End Examination: 60% (Refer format of Question paper Below)
13	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc .( at least 3 )	

### Course III - Practical I

### Title of the paper: Practicals in Immunology

Sr.No.	Heading	Particulars
1	Description the course: Including but Not limited to:	This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. A description of cells involved in the immune response either innate or acquired, organs of the immune system and specific responses. Other topics covered will include the basis and types of immune reactions.
2	Vertical :	Major
3	Туре :	Practical
4	Credits :	2 credits
5	Hours Allotted :	60 Hours
6	Marks Allotted:	50 Marks
7	<ul> <li>Course Objectives (CO):</li> <li>CO1: To provide students with a foundation in concepts related to immunology</li> <li>CO2: To familiarise with the basic principles of innate and acquired immunity.</li> <li>CO3: To provide students with knowledge on how the immune system works and depict the organs cells and organs diagrammatically.</li> <li>CO4: To acquaint the learners about the serological procedures that demonstrate the immunological reactions of agglutination and precipitation formation.</li> <li>CO5: To understand rapid immunodiagnostic screening procedures.</li> </ul>	
8	<ul> <li>Course Outcomes (OC): Learner will be able to:</li> <li>OC1: Will be able to explain the immunological terms.</li> <li>OC2: Discuss the concepts of antigen and antibody.</li> <li>OC3: Diagrammatically depict the organs of the human immune system with appropriate labels</li> <li>OC4: Explain the serological procedures demonstrating interactions between antigen and antibodies.</li> <li>OC5: Discuss the varied types of serological and immunodiagnostic methods.</li> </ul>	
9	List of Experiments: 1. Blood grouping 2. Total WBC count 3. Differential WBC ( 4. Total RBC count	Count

	<ol> <li>Separation of serum from blo</li> <li>Immunodiffusion technique -</li> <li>Quantitative Immunodiffusion Mancini</li> <li>DOT - ELISA</li> <li>Serum Electrophoresis</li> <li>Qualitative detection of Salmediation of Salmediative detection of Salmediative Agglutination-RA Fail</li> <li>Coomb's test (Direct)</li> <li>Complement Fixation Test (Complement Fixation Test (Complement Fixation Test)</li> </ol>	od Double immunodiffusion test by Ouchterlony. technique - Single Radial Immunodiffusion by onella spp - Rapid Slide agglutination test nonella spp - Tube Agglutination test ctor Test FT)
10	Text Books —-	
11	<ul> <li>Reference Books:</li> <li>1. Microbiology - A Laboratory Manual, 7th Edition, Cappuccino and Sherman, Pearson Education</li> <li>2. Practical immunology, Frank Hay, 4th Edition, Blackwell Science</li> <li>3. Medical Microbiology, Anantnarayan and Paniker</li> <li>4. Immunology, fifth Ed Goldsby, T J. Kindt, Osborne, Janis Kuby Freeman and company.</li> </ul>	
12	Internal Continuous Assessment: 40%	Semester End Examination: 60% (Refer format of Question paper Below)
13	Continuous Evaluation through: (Refer format of Question paper Below)	

### Course IV- Practical II

### Title of the paper: Practicals in Molecular Biology

Sr.N o.	Heading	Particulars
1	Description the course : Including but Not limited to: This molecular biology laboratory course equips student with practical skills in genomic and proteomic technique covering DNA and RNA extraction, electrophoret profiling, molecular techniques and spectrophotometr analysis. Students will learn critical laboratory technique through hands-on experiments and demonstration developing comprehensive skills in molecular research ar biotechnological investigations.	
2	Vertical :	Major
3	Туре :	Practical
4	Credits :	2 credits
5	Hours Allotted : 60 Hours	
6	Marks Allotted:	50 Marks
7	<ul> <li>Course Objectives(CO):</li> <li>CO 1. To develop practical skills in genomic DNA and RNA extraction techniques.</li> <li>CO 2. To learn fundamental molecular biology laboratory methods.</li> <li>CO 3. To understand the principles of molecular analysis and characterization.</li> <li>CO 4. To learn advanced techniques for studying genetic and protein interactions.</li> </ul>	
8	<ul> <li>Course Outcomes (OC): Learner will be able to</li> <li>OC1: Execute molecular biology extraction and separation techniques with.</li> <li>OC2: Analyze and interpret molecular data using spectrophotometric and electrophoretic methods.</li> <li>OC3: Demonstrate comprehensive understanding of genetic expression and molecular interaction principles.</li> <li>OC4: Design and critically evaluate experimental strategies for investigating cellular molecular processes.</li> </ul>	
9	Module:	
	<ol> <li>Isolation of genomic DNA from plant cells.</li> <li>Isolation of genomic DNA from bacterial cells.</li> <li>Comparative genomic DNA profiling from different organisms using AGE.</li> <li>Isolation and detection of RNA from bacteria or yeast.</li> <li>Purity assessment of extracted RNA samples using spectrophotometry.</li> <li>Purity assessment of extracted DNA samples using spectrophotometry.</li> </ol>	

	<ul> <li>7. Protein extraction from plant ce</li> <li>8. Protein extraction from bacteria</li> <li>9. Separation of extracted proteins</li> <li>10. DNA Amplification – PCR. (Der</li> <li>11. Demonstration of protein-DNA doable</li> <li>12. Study of <i>lac</i> gene expression us</li> <li>13. DNA microarray - Demonstration</li> <li>14. Chromatin immunoprecipitation</li> <li>15. Virtual lab for transcription and https://learn.genetics.utah.edu/</li> </ul>	IIs. I cells. s using PAGE. nonstration0 interactions through gel shift assays. is this sing blue-white selection. on. - Demonstration. translation - content/basics/transcribe.
10	Text Books: —	
11	<ol> <li>Reference Books:         <ol> <li>Sambrook, J., &amp; Russell, D. W. (2001). Molecular cloning: A laboratory manu (3rd ed.). Cold Spring Harbor Laboratory Press.</li> <li>Brown, T.A. (2016). Gene Cloning and DNA Analysis: An Introduction. 7th e Chichester: John Wiley &amp; Sons Ltd.</li> <li>Green, M.R. &amp; Sambrook, J. (2012). Molecular Cloning: A Laboratory Manu (Fourth Edition). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press</li> <li>Primrose, S.B. &amp; Twyman, R. (2006). Principles of Gene Manipulation ar Genomics. 7th Edition. Chichester: Wiley-Blackwell. ISBN: 978-1-405-13544-3.</li> <li>Dieffenbach, C.W. &amp; D'Veksler, G.S. (2003). PCR Primer: A Laboratory Manua 2nd ed. Cold Spring Harbor Laboratory Press.</li> </ol> </li> </ol>	
12	Internal Continuous Assessment: 40%	Semester End Examination: 60% (Refer format of Question paper Below)
13	Continuous Evaluation through: (Refer format of Question paper Below)	

## Vertical - 4



### Title of the paper: Introduction to Bioinformatics

Sr.N o.	Heading	Particulars	
1	Description the course: Including but Not limited to:	This course provides an in-depth exploration of biological databases and sequence analysis tools, essential for modern bioinformatics and molecular biology. Emphasis is placed on practical applications, such as detecting restriction enzyme sites using NEBcutter, designing PCR primers with NCBI Primer BLAST, and predicting protein domains, motifs, and functions using InterPro. Additionally, students will gain experience in chemical structure analysis using the PDB Chemical Component Dictionary and apply bioinformatics skills to real-world assignments, including designing primers for gene amplification	
2	Vertical :	VSC	
3	Туре :	Practical	
4	Credits :	2 credits	
5	Hours Allotted :	ours Allotted : 30 Hours	
6	Marks Allotted:	50 Marks	
7	<ul> <li>Course Objectives(CO):</li> <li>1. The primary objective of this course is to provide students with a comprehensive understanding of biological databases and sequence analysis tools.</li> <li>2. The course aims to equip learners with the skills to retrieve and analyze DNA and protein sequences, perform sequence alignment, classify proteins, and predict protein structures and functions.</li> <li>3. Additionally, the course emphasizes hands-on experience with molecular visualization tools, restriction mapping and primer design.</li> </ul>		
8	Course Outcomes (OC): Learner will be able to		
	<ol> <li>Demonstrate proficiency in retrieving DNA and protein sequences from major biological databases such as GenBank, UniProt, and PDB.</li> <li>Perform pairwise and multiple sequence alignments using tools such as BLAST and Clustal Omega to analyze nucleotide and protein sequences.</li> <li>Use chemical sketch tools and the PDB Chemical Component Dictionary to search for and analyze molecular structures.</li> <li>Visualize and interpret 3D molecular structures using tools like PyMOL and Swiss-PDB Viewer.</li> <li>Classify proteins based on their structural and functional properties using classification systems like CATH and SCOP.</li> <li>Detect restriction enzyme sites and design custom restriction digests using NEBcutter.</li> </ol>		

	<ol> <li>Predict domains, motifs, and functions of proteins using bioinformatics tools such as InterPro.</li> <li>Design primers for PCR amplification using NCBI Primer BLAST and validate their suitability for target gene amplification.</li> </ol>
9	<ul> <li>Modules:- Biological Databases and Analysis Tools <ol> <li>Introduction to Biological Databases: GenBank, EMBL, PDB, UniProt, Ensembl.</li> <li>Retrieve a sequence from Databases: Retrieve a DNA sequence from GenBank.</li> <li>Retrieve a sequence from Databases: Retrieve a Protein sequence from UniProt, PDB.</li> </ol> </li> <li>Sequence alignment: Pairwise and Multiple Sequence Alignment of nucleotide sequences using BLASTn and Clustal Omega.</li> <li>Sequence alignment: Pairwise and Multiple Sequence Alignment of protein sequences using BLASTp, Clustal Omega and PDB tool.</li> <li>Chemical Sketch Tool- Search for matching molecules in the PDB Chemical Component Dictionary.</li> <li>Visualization PDB Molecules using PyMOL and Swiss-PDB Viewer.</li> <li>Classification of Proteins using CATH and SCOP.</li> <li>Detect restriction enzyme sites on a sequence map and perform a custom digest with selected enzymes using NEBcutter.</li> <li>Predict domains, motifs, and functions of proteins using InterPro.</li> <li>PCR Primer design using NCBI Primer BLAST.</li> <li>Verification of sequence for a target gene and primers for amplification of the gene. (based on published article).</li> </ul>
10	<ul> <li>Reference Book <ol> <li>Mount, David W Bioinformatics: Sequence and Genome Analysis. Thailand, Cold Spring Harbor Laboratory Press, 2004.</li> <li>Bioinformatics - Volume I: Data, Sequence Analysis, and Evolution. Second Edition Jonathan M. Keith, Monash University, Humana Press</li> <li>Bioinformatics for DNA Sequence Analysis, David Posada, University of Vigo, Spain, Humana Press</li> </ol></li></ul>
11	<ul> <li>Web Links <ol> <li><u>https://www.ncbi.nlm.nih.gov/</u></li> <li><u>https://www.ebi.ac.uk/jdispatcher/</u></li> <li><u>https://www.uniprot.org/</u></li> <li><u>https://www.ebi.ac.uk/interpro/</u></li> <li><u>https://www.rcsb.org/alignment</u></li> <li><u>https://www.pdbus.org/docs/search-and-browse/advanced-search/chemical-sketch-tool</u></li> <li><u>https://www.ebi.ac.uk/jdispatcher/msa/clustalo</u></li> <li><u>https://www.ncbi.nlm.nih.gov/tools/primer-blast/</u></li> <li><u>https://nc3.neb.com/NEBcutter/</u></li> </ol></li></ul>

12	Internal Continuous Assessment: 40%	Semester End Examination: 60% (Refer format of Question paper Below)
13	Continuous Evaluation through: (Refer format of Question paper Below)	

## Sem. - IV

### Course I

### Title of the paper: Biochemistry

Sr.No.	Heading	Particulars
1	Description the course: Including but Not limited to:	The course provides a comprehensive explanation of enzyme kinetics and the catabolic pathways of carbohydrates and lipids. Students will explore the principles governing enzyme activity and regulation, alongside detailed study of the metabolic processes that break down carbohydrates and lipids for energy production.
2	Vertical :	Major
3	Туре :	Theory
4	Credits :	2 credits
5	Hours Allotted :	30 Hours
6	Marks Allotted:	50 Marks
7	<ul> <li>Course Objectives(CO):</li> <li>CO 1: To explain the classification system for enzymes based on the reactions they catalyze.</li> <li>CO 2: To explain and interpret model to describe enzyme kinetics and describe the various <ul> <li>mechanisms that regulate enzyme activity</li> </ul> </li> <li>CO 3: Illustrate the major pathway of carbohydrate metabolism glycolysis, citric acid cycle role of key enzymes and energetics and oxidative phosphorylation in energy production.</li> <li>CO4 :To describe the digestion, absorption, and transport of lipids in the human body and explain the pathways of lipid metabolism, including beta-oxidation, fatty acid synthesis</li> </ul>	
8	<ul> <li>Course Outcomes (OC): Learner will be able to:</li> <li>OC 1: Have a deeper insight in to the fundamentals <u>of</u> enzyme properties, nomenclatures, and classification</li> <li>OC 2: Understand the kinetics of enzyme catalysed reactions and enzyme inhibitions and regulatory processes.</li> <li>OC 3: Understand key pathways in carbohydrate and Lipid metabolism and the energetics</li> <li>OC 4: Describe the role of the citric acid cycle and oxidative phosphorylation in energy production and their connection to carbohydrate and lipid metabolism.</li> </ul>	
9	Modules:- Module 1: Enzymology	/
24		

	<ul> <li>Understanding the basic terminology in enzymology: Enzyme, Apoenzyme, Holoenzyme, Prosthetic group, Active site, Turnover number, Specific activity, Katal, IU, Coenzyme and Cofactor (3 Lectures)</li> <li>Classification, Nomenclature of Enzymes (2 Lectures)</li> <li>Enzyme specificity: (4 Lectures)</li> <li>Concept of active site, ES complex, transition state Effect of pH, Temperature, Substrate Concentration on Enzyme Activity,</li> <li>Enzyme Kinetics - Michaelis-Menten Equation, Line weaver Burk plot for mono substrate reaction, Concept</li> </ul>
	<ul> <li>and Significance of V<sub>max</sub> and K<sub>m</sub> (4 Lectures)</li> <li>Types of Enzyme Inhibitions-</li> </ul>
	Competitive, Uncompetitive, Non-Competitive (2 Lectures)
	Module 2: Carbohydrate and Lipid Metabolism
	<ul> <li>Carbohydrate Metabolism:         <ul> <li>Glycolytic Pathway and energetics - EMP pathway and its regulation, Pyruvate oxidation, role of PDH enzyme, Pasteur effect</li> <li>Anaerobic fate of Pyruvate- Alcoholic and Homolactic fermentation</li> <li>Citric Acid cycle and energetics, Amphibolic nature of TCA cycle and its regulation (3 Lectures)</li> </ul> </li> <li>ETC - Structure of Mitochondria, Complexes of ETC and oxidative phosphorylation ,Inhibitors of ETC         <ul> <li>Lipid Metabolism:</li> <li>Mobilization and transport of fatty acids</li> <li>Lecture)</li> </ul> </li> </ul>
	Beta,alpha and Omega Oxidation of saturated fatty acid     (3 lectures)
10	<ul> <li>Text Books:</li> <li>1.Outlines of Biochemistry: 5th Edition, (2009), Erice Conn &amp; Paul Stumpf; John Wiley and Sons, USA</li> <li>2. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson &amp; Michael Cox, W.H. Freeman and company, NY.</li> </ul>
11	<ul> <li>Reference Books:</li> <li>1. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA</li> <li>2. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet&amp; Judith Voet, John Wiley and Sons, Inc. USA</li> <li>3. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY</li> </ul>

12	Internal Continuous Assessment: 40%	Semester End Examination: 60% (Refer format of Question paper)
13	<b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

### Course II Title of the paper: Medical Biotechnology

Sr.No.	Heading	Particulars	
1	Description the course: Including but not limited to:	The course provides insights into host-pathogen interaction, disease outcome and epidemiological principles. The students will get detailed knowledge of isolations of pathogens from clinical samples and susceptibility testing.	
2	Vertical:	Major	
3	Туре:	Theory	
4	Credits:	2 credits	
5	Hours Allotted:	30 Hours	
6	Marks Allotted:	50 Marks	
7	<ul> <li>Course Objectives (CO):</li> <li>CO 1: To gain insight into various modes of transmission, virulence factors of pathogens and factors associated with hosts which are associated with disease outcome.</li> <li>CO 2: To understand principles of epidemiology and its role in control, treatment and prophylaxis of disease.</li> <li>CO 3: To provide knowledge on the handling, isolating and identifying various pathogens.</li> <li>CO 4: To suggest suitable antibiotics for therapy by doing susceptibility tests</li> </ul>		
8	<ul> <li>Course Outcomes (OC): Learner will be able to:</li> <li>OC 1. Describe the role of host factors, virulence factors and various modes of transmission in the outcome of disease.</li> <li>OC 2. Understand principles of epidemiological sciences in studying the underlying mechanisms of spread of disease and controls required thereof to combat the spread of pathogens</li> <li>OC 3. Learner will know how to isolate and Identify pathogens of the respiratory tract, gastrointestinal tract, urinary tract, skin and nosocomial infections.</li> <li>OC4: Learner will know how to perform Antimicrobial Susceptibility Testing and suggest suitable drugs for treatment.</li> </ul>		
9	Module 1: Ger parasite interac	neral Bacteriology and Bacteria as Human pathogen, Host ctions	

	<ul> <li>Host Parasite Relationship: Koch's Postulates. (1 lecture)</li> <li>Normal Flora of human body &amp; various pathogens associated with each part.</li> <li>Concept of Microbiome, Germ-free animals (2 lecture)</li> <li>Origin of Pathogens &amp; Acquisition of Infection- Vectors, sources of infection, various routes of transmission (3 lecture)</li> <li>Factors Affecting the Course of Infection and Disease: (1 lecture)</li> <li>Mechanisms of Infection and Virulence Factors (Adhesion factors, Capsule, Enzymes, Toxins). (2 lectures)</li> <li>Various stages of clinical infections. (1 lecture)</li> <li>Patterns of Infection; Types of Infections; Signs and Symptoms. (2 lecture)</li> <li>Introduction to Epidemiology and Epidemiological Markers. (1 lecture)</li> <li>Opportunistic pathogens, Nosocomial infections. (2 lectures)</li> </ul>		
	Module 2: Infectious diseases		
	<b>Introduction:</b> Various pathogens associated with various systems (skin, Respiratory tract, Gastrointestinal tract, Genitourinary tract, central nervous system) and diseases caused by them (disease caused and pathogen responsible) (1 Lecture)		
	Following to be covered for the pathogen mentioned: Pathogenesis, symptoms and laboratory diagnosis, epidemiology, prophylaxis and treatment.		
	<ul> <li>Skin infections - S. aureus (2 lectures)</li> <li>Urinary tract infections: E. coli, Proteus sp. (2 lectures)</li> <li>Respiratory Tract Infections: M. tuberculosis (2 lectures)</li> <li>Gastrointestinal tract infections: Enteric fever- Salmonella (2 lectures)</li> <li>Sexually transmitted disease: Syphilis (2 lectures)</li> <li>Nosocomial infections: Pseudomonas aeruginosa (1 lecture)</li> <li>Fungal disease: Candidiasis (1 lecture)</li> </ul>		
10	<ol> <li>Text Books         <ol> <li>Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition</li> <li>Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication</li> <li>Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY</li> <li>Prescott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood,</li> <li>Foundations in Microbiology by K.P.Talaro, B.Chess, McGrawHill Education, 10th Edition</li> <li>Microbiology An Introduction, 10th Edition Gerard J.Tortora, Erdell R.Funke, Christine L. Case.</li> </ol> </li> </ol>		
11	<ul> <li>Reference Books</li> <li>Mim's Medical microbiology Richard V Goering, Hazel M Dockrell, Mark Zuckerman, Peter L Chiodini, Ivan M Roitt Fifth edition, Elsevier.</li> </ul>		

	2. Koneman's Color Atlas and Textbook of Diagnostic Microbiology by Gary W. Procop, Deirdre L. Church, Geraldine S. Hall (z-lib.org)		
12	Internal Continuous Assessment: 40%	Semester End Examination: 60% (Refer format of Question paper Below)	
13	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)		

### Course III

### Title of the paper : Practicals in Biochemistry

Sr.No.	Heading	Particulars	
1	Description the course : Including but Not limited to:	The present course provides students practical based skills in the study of enzymes and the biochemical processes of carbohydrate and lipid metabolism. The course is designed to complement theoretical knowledge by offering students the opportunity to perform laboratory experiments that investigate enzyme activity,extraction, detection kinetics, and the regulation of metabolic pathways using techniques like chromatography,colorimeter.	
2	Vertical : Major		
3	Туре :	Practicals	
4	Credits :	2 credits	
5	Hours Allotted :	60 Hours	
6	Marks Allotted:	50 Marks	
7	<b>Course Objectives(CO):</b> CO 1: To develop proficiency in using laboratory techniques such as chromatography ,colorimetric for enzymology and metabolism studies CO 2: To analyze carbohydrate levels in samples using colorimetric assays CO3:To evaluate the effect of pH,temperature, inhibitors on Enzyme activity and Kinetics.		
8	Course Outcomes (OC): Learner will be able to: OC 1: Demonstrate the ability to perform and analyze enzyme-catalyzed reactions, including the determination of enzyme activity OC 2: Interpret enzyme kinetics and determine V max and Km for an enzyme OC 3: Detect and quantitate Biomolecules		

9		Practicals:			
		1.	Estimation of Reducing sug	ar by DNSA method	
			Amylase/ Proteolytic )		
		3. Study of the effect of pH on		$\boldsymbol{\beta}$ amylase activity	
		4.	Study of the effect of Tempe	erature on $β$ amylase activity	
		5.	Study of the effect of Inhibito	ors on $m eta$ amylase activity	
		6.	Study of Effect of Substrate	Concentration on enzyme activity and	
		_	determination of Vmax and I	(m)	
		7.	Isolation of Mitochondria and Enzyme.	d Demonstration of ETC using a Marker	
		8.	Separation of fatty acids by	TLC.	
		9.	Meat tenderization using paper	pain.	
		10	. Study of titration curve of an	nino acids.	
		11	. Activity of Salivary Amylase	on Starch	
		12	. Immobilization of enzymes b	y entrapment method.	
		13	Assignment- The application	of enzymes in the production of active	
		pharmaceutical ingredients (APIs), drug synthesis, and how they help			
		1/	Assignment- Cancer cell me	tabolism-key altered enzymes	
		14. Assignment- Cancer cell metabolism-key altered enzymes.			
10 Text Books		Books			
		1.	Biochemical methods, 4th ed Age International Publishers	dition, S.Sadasivam and A.Manickam, New .	
11	I	Reference Book:			
		1.	TATA McGrawHill Edition.	biochemistry, sid edition, bavid i idminier,	
		2.	2. Experimental Biochemistry: A Student Companion (2005), Beedu		
			Shashidhar Rao and Vijay Deshpande, New Delhi: I.K. International.		
Narosa Publishing House.		Narosa Publishing House.	emistry, S.K. Sawnney and Randhir Singh,		
12	In	ternal	Continuous Assessment:	Semester End Examination: 60%	
	40	%		(Refer format of Question paper Below)	
13	Co	ontinuo	ous Evaluation through:		
(Refer format of Question paper		rmat of Question paper			
	Be	elow)			

### Course IV

### Title of the paper: Practicals in Medical Biotechnology

Sr.No.	Heading	Particulars	
1	Description the course : Including but Not limited to:	The course provides practical knowledge of isolation of pathogens from clinical samples and antibacterial susceptibility testing.	
2	Vertical :	Major	
3	Туре :	Practical	
4	Credits :	2 credits	
5	Hours Allotted :	60 Hours	
6	Marks Allotted:	50 Marks	
7	<ul> <li>Course Objectives(CO):</li> <li>1. To understand and detect virulence factors of pathogens.</li> <li>2. To isolate various pathogens from clinical samples with the help of suitable selective and differential media and biochemicals.</li> <li>3.</li> </ul>		
8	<ul> <li>Course Outcomes (OC): Learner will be able to</li> <li>1.Select suitable media and biochemicals for isolation of pathogens from clinical samples.</li> <li>2. Detection of virulence factors of pathogens.</li> <li>3. Isolate &amp; identify pathogens.</li> </ul>		
	Practicals         1.Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar,,Wilson and Blair's Agar         2.Isolation and Identification of <i>S.aureus using</i> selective and differential media S.aureus-Isolation,Biochemicals - Catalase,Coagulase Test         3.Isolation of <i>E.coli</i> using selective and differential media and Identification of <i>E.coli</i> . E.coli-Isolation, Biochemical test-Sugar Fermentations,IMViC         4.Isolation and identification of <i>Salmonella using selective</i> and differential media         Salmonella- Isolation, Biochemical test-Sugar Fermentations,IMViC         4.Isolation of <i>Pseudomonas</i> and identification of using selective and differential media         Salmonella- Isolation, Urease test         4.Isolation of <i>Pseudomonas</i> and identification of using selective and differential media		

	<ul> <li>7. Isolation of <i>Proteus</i> and identification of using selective and differential media-Pseudomonas - Isolation, Urease test, TSI Slant</li> <li>8. Acid fast staining Mycobacterium Permanent slide.</li> <li>9. To demonstrate Germ tube (Demonstration)</li> <li>10. Detection of Virulence factors – (a) Lecithinase(b) Hemolysin (c) Coagulase (d)Streptokinase</li> </ul>		
10	Text Books         1. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition.         2. Koneman's Color Atlas and Textbook of Diagnostic Microbiology by Gary W.         Procop, Deirdre L. Church, Geraldine S. Hall (z-lib.org)		
11	Reference Books		
12	Internal ContinuousSemester End Examination: 60%Assessment: 40%(Refer format of Question paper Below)		
13	Continuous Evaluation through: (Refer format of Question paper below)		

## SEC

### Title of the paper: Microbial Laboratory Techniques

Sr.No.	Heading Particulars		
1	Description the course: Including but Not limited to:	This course emphasizes microbial techniques to be performed under aseptic conditions. The students will learn to culture and handle bacteria, yeast and fungi.; to preserve cultures for further use; to extract enzymes from bacteria; to identify mutants; to extract important cell components; to make observations and interpret the results. These techniques will help the students to hone their skills in the field and enhance their job/ research opportunities.	
2	Vertical :	SEC	
3	Туре :	Practical	
4	Credits :	2 credits	
5	Hours Allotted : 30 Hours		
6	Marks Allotted: 50 Marks		
7	<ul> <li>Course Objectives(CO):</li> <li>CO1:Students get exposure to various microbiological techniques which are a prerequisite in various fields and in demand in industry.</li> <li>CO 2: Develop an understanding how microbiology is relevant to technological developments for industries related to food and fermentations.</li> <li>CO3: The students will acquire the necessary skills in Microbial Laboratory Techniques which will help them to get good placement in industry, research institutes or teaching.</li> </ul>		
8	Course Outcomes (OC): Major learning outcome of this course is that students study and identify microorganisms and develop a very good understanding of several microbiological techniques which are among the basic skills expected from a practicing microbiologist. OC1: Learner will be able to learn various microbiological techniques and to maintain aseptic conditions and proper handling of glasswares, media.		
	chemicals, etc. OC2: Learner will be able to acquire the necessary skills to enable suitable employment.		
9	<ul> <li>Modules:-</li> <li>1. Isolation of fungi from different sources.</li> <li>2. Preservation of microbial cultures by various techniques.</li> <li>3. Microbial examination of sterile and non sterile products.</li> </ul>		

	<ol> <li>Replica plate technique to isolate drug resistant mutants.</li> <li>Gradient plate technique to isolate drug/dye resistant mutants</li> <li>MPN estimation - [Presumptive, Confirmed and Completed] of bacteria in liquid culture/water.</li> <li>Slide culture of Streptomyces.</li> <li>Microbial methods of determination of Penicillin/ Streptomycin.</li> <li>Enrichment and isolation of Rhizobium species on Yeast mannitol agar (YMA)</li> <li>Single cell protein Biomass production at flask level (Yeast/ Spirulina)</li> <li>Estimation of invertase enzyme activity by immobilization of yeast.</li> <li>Pigment production from any one fungus</li> <li>Workshop/ seminar with industrial collaboration on interactions with Entrepreneurs in Microbial Biotechnology and startups.</li> </ol>		
10	Text Books		
	<ol> <li>Alexopoulus, C.J., Mims,C.V John Wiley, New York.</li> </ol>	V. and Blackwell, M, Introductory Mycology.	
	<ol> <li>Microbiology - A Laboratory Sherman.</li> </ol>	Manual - James Cappuccino and Natalie	
	<ol> <li>A Textbook of Pharmaceutical Microbiology Paperback (2018) by Pulak Mujumder, Sameer Rajan Sahoo Everest Publishing</li> </ol>		
	<ol> <li>Practical Microbiology by R C Dubey and D K Maheshwari.2002. Chand Publications.</li> </ol>		
	<ol> <li>BlackJ.G.Microbiology-Principles Explorations.JohnWiley&amp;SonsInc NewYork,(2002).</li> </ol>		
	<ul> <li>6. Tom Besty, D.C Jim Koegh. Microbiology Demystified McGRAW-HILL.</li> <li>7. Madigan, Martinko, Bender, Buckley, Stahl. Brock Biology of</li> </ul>		
	Microorganisms. Pearson. 8. H.D. Kumar and H.N. Singh.A Textbook on Algae (Macmillan international college edition)		
11	<ul> <li>Reference Books         <ol> <li>Mehrotra, R.S. and K.R.Aneja An Introduction to Mycology. New Age International A. V. S. S. Sambamurty. A Textbook of Algae. I.K. International Publishing House Pvt. Limited, 2010.</li> <li>Richard H. Baltz. Julian E Davies and Arnold L.Demain Manual of</li> </ol> </li> </ul>		
	Microbiology and Biotechnology. 3rd edition, ASM Press (2010).		
12	Internal ContinuousSemester End Examination: 60%Assessment: 40%(Refer format of Question paper Below)		
13	Continuous Evaluation through: (Refer format of Question paper Below)		

### QUESTION PAPER PATTERN (External and Internal)

### **Evaluation Pattern**

MAJOR:8 credits

### Scheme 1:

Theory/Practica	Credits	No. of	Mark
I		Hours	S
Theory: Paper 1	2	30	50
Theory: Paper 2	2	30	50
Practical 1	2	60	50
Practical 2	2	60	50

### **Evaluation Pattern:**

#### Theory Paper

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Continuous Evaluation through:	As per paper	1 hour
Quizzes, Class Tests, presentation,	pattern	
project, role play, creative writing,		
assignment etc. (at least 3)		

### **Practicals**

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks)/ or 2 practicals (Minor) (N/2) to be performed and assessed = 20 Marks	One experiment (25 marks for experiment and 5 Marks for Journal = 30 Marks)	3h 30 minutes

### **PRACTICAL BOOK/JOURNAL**

The learners are required to perform 75% of the Practical for the journal to be duly certified. The learners are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

### Paper pattern as per scheme 1

### <u>Theory</u> (2 credit course)

### Internal

Internal Continuous Assessment =20

Quizzes/MCQ/ Class tests/ Project/ Assignments/ oral presentation (poster /power point (any three)

### External

Format of Question Paper: 30 marks					
Q. No.	Description	Module	Marks		
1	MCQ/Do as directed (Any 5 of 10)	1 and 2	05		
2	Answer in Brief/ Long Answer Questions/Justify/Discuss /Long answer question - Any 2 of 4	1	10		
3	Answer in Brief/ Long Answer Questions/Justify/Discuss /Long answer question - Any 2 of 4	2	10		
4	Application Based Question (Can be divided in sub questions with internal options)	1 & 2	5		
		Total	30		

### Practical - 2 credit course

### Internal

Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks)/ Any 1(Major) or 2 practicals (Minor) (N/2) to be performed and assessed = 20 Marks

### **Practical- Semester end examination**

One experiment (25 marks for experiment ) or 1 major experiment 15 marks and 1 minor experiment- 10 marks and 5 Marks for Journal = 30 Marks) Duration-3 h 30 minutes

### VSC/SEC

#### Internals

Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks) / Any 1(Major) or 2 practicals (Minor ) (N/2) to be performed and assessed = 20 Marks

#### **Practical- Semester end examination**

30 Marks per paper Semester End Theory Examination: One experiment (25 marks for experiment) or 1 major experiment 15 marks and 1 minor experiment- 10 marks and 5 Marks for Journal = 30 Marks) Duration - These examinations shall be of **Three hours** duration in laboratory

#### Letter Grades and Grade Points:

Semester GPA/ Programme CGPA	% of Marks	Alpha-Sign/ Letter Grade Result	Gradin g Point
Semester/ Programme			-
9.00 - 10.00	90.0 -100	O (Outstanding)	10
8.00 - < 9.00	80.0 <90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 < 60.0	B(Above Average)	6
5.00 - < 5.50	50.0 < 55.0	C (Average)	5
4.00 - < 5.00	40.0 <50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sd/-Sign of the BOS Chairman Dr. Varsha Kelkar-Mane Chairman BOS in Biotechnology Sd/-Sign of the Offg. Associate Dean Dr. Madhav R. Rajwade Faculty of Science & Technology Sd/-Sign of the Offg. Dean Prof. Shivram S. Garje Faculty of Science & Technology