University of Mumbai

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Academic Authorities,
Meetings & Services (AAMS)
Room No. 128, M. G. Road, Fort,
Mumbai – 400 032.
Tel. 022-68320033

Re- accredited with A ++ Grade (CGPA 3.65) by NAAC
Category- I University Status awarded by UGC

No.AAMS_UGS/ICC/2024-25/228 Date: 06th February, 2025

CIRCULAR:-

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head of the University Departments is invited to this office Circular No. AAMS_UGS/ICC/2023-24/23 dated 08th September, 2023 relating to the NEP UG & PG Syllabus.

They are hereby informed that the recommendations made by the **Ad-hoc Board of Studies in Biotechnology** at its meeting held on 29th October, 2024 and subsequently passed by the Board of Deans at its meeting held on 30th November, 2024 **vide** Item No.6.1 (R) have been accepted by the Academic Council at its meeting held on 4th December, 2024 **vide** item No.6.33 (R) and in accordance therewith marks for the 2 credit SEC courses amended from 100 to 50 in the syllabus of **B.Sc. (Biotechnology) (Sem. I & II)** for the following SEC course as per appendix (NEP 2020) with effect from the academic year 2024-25.

	Sem	Title	Credits	Marks
B.Sc. (Biotechnology) SEC	I	Microbial Techniques **OR** Clinical Biochemistry	2	50
	II	Physicochemical Analysis of Soil and Water **OR** Food Adulteration	2	50

(The Circular is available on the University's website www.mu.ac.in).

(Dr. Prasad Karande)
REGISTRAR

MUMBAI – 400 032
06th February, 2025

To

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head of the University Departments.

AC./6.33 (R) 04/12/2024

Copy forwarded with Compliments for information to:-

1) The Chairman, Board of Deans,
2) The Dean, Faculty of Science & Technology,
3) The Chairman, **Ad-hoc Board of Studies in Biotechnology**
4) The Director, Board of Examinations and Evaluation,
5) The Director, Department of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Director, Centre for Distance and Online Education (CDOE) Vidyanagari,
8) The Deputy Registrar, Admission, Enrolment, Eligibility & Migration Department (AEM),

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
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 cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in 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), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
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, thanesubcampus@mu.ac.in
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, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), dlleuniversityofmumbai@gmail.com

Copy 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 pvc@fort.mu.ac.in
2	**Faculty of Humanities,** **Dean** 1. Prof.Anil Singh Dranilsingh129@gmail.com **Associate Dean** 2. Dr.Suchitra Naik Naiksuchitra27@gmail.com 3.Prof.Manisha Karne mkarne@economics.mu.ac.in
	Faculty of Commerce & Management, **Dean** 1. Dr.Kavita Laghate kavitalaghate@jbims.mu.ac.in **Associate Dean** 2. Dr.Ravikant Balkrishna Sangurde Ravikant.s.@somaiya.edu 3. Prin.Kishori Bhagat kishoribhagat@rediffmail.com

	Faculty of Science & Technology **Dean** 1. Prof. Shivram Garje ssgarje@chem.mu.ac.in **Associate Dean** 2. Dr. Madhav R. Rajwade Madhavr64@gmail.com 3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies, **Dean** 1.Dr. Anil K. Singh aksingh@trcl.org.in **Associate Dean** 2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
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 - 04/12/2024
Item No. 6.33 (R)

As Per NEP 2020

University of Mumbai

Title of the program

A- U.G. Certificate in Biotechnology
B- U.G. Diploma in Biotechnology
C- B.Sc. (Biotechnology)
D- B.Sc. Hons. (Biotechnology)
E- B.Sc. Hons. with Research (Biotechnology)

Syllabus for

Semester – Sem I to II

Ref: GR dated 20th April, 2023 for Credit Structure of UG

(With effect from the academic year 2023-24 Progressively)

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars	
1	**Title of program** **O: _____A**	**A**	**U.G. Certificate in Biotechnology**
	O: _____B	**B**	**U.G. Diploma in Biotechnology**
	O: _____C	**C**	**B.Sc. (Biotechnology)**
	O: _____D	**D**	**B.Sc. Hons. (Biotechnology)**
	O: _____E	**E**	**B.Sc. Hons. with Research (Biotechnology)**
2	**Eligibility** **O: _____A**	**A**	(10+2) A learner must have passed H.Sc. (Science) **OR** Passed Equivalent Academic Level 4.0
	O: _____B	**B**	Under Graduate Certificate in Biotechnology **OR** passed equivalent Academic Level 4.5
	O: _____C	**C**	Under Graduate Diploma in Biotechnology **OR** passed equivalent Academic Level 5.0
	O: _____D	**D**	Bachelors of Biotechnology **OR** passed equivalent with minimum CGPA of 7.5 Academic Level 5.5
	O: _____E	**E**	Bachelors of Biotechnology **OR** passed equivalent with minimum CGPA of 7.5 Academic Level 5.5
3	**Duration of program** **R: _____**	**A**	One Year
		B	Two Years
		C	Three Years
		D	Four Years
		E	Four Years
4	**Intake Capacity** **R: _____**	**60 students per division**	

5	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination	
6	**R: _____ Standards of Passing**	40%	
7	**Sem. I & II Credit Structure** **R: _____A** **R: _____B**	Attached herewith	
	Sem. III & IV Credit Structure **R: _____C** **R: _____D**		
	Sem. V & VI Credit Structure **R: _____E** **R: _____F**		
8	**Semesters**	A	Sem I & II
		B	Sem III & IV
		C	Sem V & VI
		D	Sem VII & VIII
		E	Sem VII & VIII
9	**Program Academic Level**	A	4.5
		B	5.0
		C	5.5
		D	6.0
		E	6.0
10	**Pattern**	Semester	
11	**Status**	New	
12	**To be implemented from Academic Year Progressively**	From Academic Year: 2023-24	

Sign of the BOS Chairman
Dr. Varsha Kelkar-Mane
Ad-hoc BoS in (Biotechnology)

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Ad-hoc BoS Faculty of Science & Technology

Sign of the Offg. Dean Prof. Shivram S. Garje Faculty of Science & Technology

Preamble

1) 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 as refining, environmental remediation, agriculture and food production, healthcare, pharmacy, animal husbandry, textiles, and nutrition. Learners after completing their biotechnology course can find suitable employment in the research and development, laboratories, pharmacies etc. The syllabus herein discusses the subjects offered at undergraduate level highlighting the respective course as well as program outcomes

2) 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.

3) 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 opportunity 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.

5) Credit Structure of the Program (Sem I, II, III, IV, V & VI)

Under Graduate Certificate in Biotechnology

Credit Structure (Sem. I & II)

	R:_____A								
Level	Sem	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC ,IKS	OJT,FPCEP, CC, RP	Cum. Cr./ Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
4.5	I	6 (4T+2P) Course I 2 units Fundamentals of Biotechnology -I (2 Credits) Course II – 2 units Microbial Biotechnology (2 Credits) Practical (2 Credits)		-	4 Credits	VSC:2 Credits Lab based Select Any One Instrumentation in Biotechnology Computers in Biology SEC:2 Credits Lab Based Select Any One Microbial Techniques Clinical Biochemistry		CC:2 credits	22	UG Certificate 44
	R:_____B									
	II	6 (4T+2P) Course III – 2 units Fundamentals of biotechnology -II (2 Credits) Course IV- 2 units Molecular Biology I & Molecular Genetics (2 Credits) Practical (2 Credits)		2 Credits	4 Credits	VSC:2 Credits Lab based Select Any One Introduction to Medical Laboratory Technology Basics in R with Applications in Biotechnology SEC:2 Credits Lab Based Select Any One Physico chemical analysis of Soil & Water Food Adulteration		FP 2 Credit & CC:2 Credit	22	
	Cum Cr.	12	-	2	8	4+4	4+4 +2	4	44	
Exit option: Award of UG Certificate in Major with 40-44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										

Under Graduate Diploma in Biotechnology

Credit Structure (Sem. III & IV)

	R:_____C									
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr./ Sem.	Degree /Cum Cr.
		Mandatory	Electives							
5.0	III	8(4T+4P) Course I- 2 units Immunology Course II- 2 units Molecular biology II Practical I (2 Credits) and Practical II (2 Credits)		4 credits	(2 Credits)	VSC:2, Select Any One R Programming for Data Analysis in Biology Lab Based Medical Biotechnology		FP:2 (BT) CC:2	22	UG Diploma 88
	R:_____D									
	IV	8 (4T+4P)(4+4) Course III- 2 units Biochemistry Course IV- 2 units Analytical Techniques in Biotechnology Practical I (2 Credits) and Practical II (2 Credits)		4 credits	(2 Credits)	SEC:2 Select Any One Traditional Fermentation Techniques Nutritional Analysis of Food and Food Products		CEP: 2 (BT) CC:2	22	
	Cum Cr.	28			10	12	6+6	8+4+2	8+4	88
Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										

B.Sc. (Biotechnology)

Credit Structure (Sem. V & VI)

	R:_____E								
Level	Sem	Major		Minor	OE	VSC SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr./ Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
5.5	V	10(6T+4P) Course I- 2 units Cell Biology Course II- 2 units Genomics and Proteomics Course III- 2 units Bioinformatics and Biostatistics Practical I (2 Credits) and Practical II (2 Credits)	4 credits Any One Food Nutrition & Nutraceuticals Environment Biotechnology Agri Biotechnology Medical Biotechnology	4 credits	-	VSC: 2 Molecular Diagnostics Food Biotechnology		FP/CEP: 2 (Research Projects)	22	UG Degree 132
	R:_____F									
	VI	10(6T+4P) Course IV- 2 units Clinical Biochemistry & Immunology Course V- 2 units Bioprocess Technology Course VI- 2 units Intellectual Property Rights Practical I (2 Credits) and Practical II (2 Credits)	4 credits Any One Marine Biotechnology Animal Biotechnology Plant Biotechnology Enzyme Biotechnology	4 credits	-	Bioenergy and biofuels/ Entrepreneurship Development Quality Control management in biotechnology Biopharmaceutical technology		OJT :4 On Job Training	22	
	Cum Cr.	48	8	18	12	8+6	8+4+2	8+6+4	132	

Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor

[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 – Continuing Education Program, CC – Co-Curricular, RP – Research Project]

Evaluation Pattern

MAJOR:6 credits

Scheme 1:

Theory/Practical	Credits	No. of Hours	Marks
Theory: Paper 1	2	30	50
Theory: Paper 2	2	30	50
Practical	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: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.	As per paper pattern	1h 30 minutes

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) = 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.

VSC: 2 credits

Scheme 1: 1 practical course of 2 credits, Duration: 60 h, Total marks: 50

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

Paper Pattern for 30 marks :

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **Three hours** duration in laboratory

QUESTION PAPER PATTERN
(External and Internal)

Paper pattern as per scheme 1

Theory

Internal

Internal Continuous Assessment =20
Quizzes/MCQ/ Class tests- 10 marks
Project/ Assignments/ oral presentation(poster /power point)- 10 marks

External

Format of Question Paper: 30 marks			
Q. No.	Description	Module	Marks
1	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) = 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

Internals

Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks) = 20 Marks

Practical- Semester end examination

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **Three hours** duration in laboratory

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
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

F.Y.B.Sc. Biotechnology (USBT) Course Structure

Semester I

Ladder	Course Type	Title	Credits	Hours
Major 1	Theory	Fundamentals of Biotechnology-I	2	30
Major 2	Theory	Microbial Biotechnology	2	30
Major 3	Practical	Practical	2	60
VSC	Practical	Instrumentation in Biotechnology	2	60
OR				
VSC	Practical	Computers in Biology	2	60
SEC	Practical	Microbial Techniques	2	60
OR				
SEC	Practical	Clinical Biochemistry	2	60
OE	Theory	Nutrition, Life style diseases and their management	2	60
OE	Theory	Wine Technology	2	60

Semester II

Ladder	Course Type	Title	Credits	Hours
Major 1	Theory	Fundamentals of Biotechnology-II	2	30
Major 2	Theory	Molecular Biology & Molecular Genetics	2	30
Major 3	Practical	Practicals	2	60
Minor 1	Theory	Biotechnology and its Applications	2	30
VSC	Practical	Medical Laboratory Technology	2	60
OR				
VSC	Practical	Basics in R with Applications in Biotechnology	2	60
SEC	Practical	Physicochemical Analysis of Soil and Water	2	60
OR				
SEC	Practical	Food Adulteration	2	60
OE	Theory	Food - Preservation Techniques & Packaging	2	60
OE	Theory	Biotechnology - Industry 4.0	2	60

Semester I

Course I

Name of the Course: Fundamentals of Biotechnology-I

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	The course aims to introduce the fundamentals of biotechnology. The learner will be able develop complete understanding of the broad spectrum of biotechnology, emphasizing its relevance, applications in diverse sectors, and ethical considerations. It explores the global demand, job prospects, and connections with other disciplines. The course also focuses on biomolecules, covering carbohydrates, lipids, amino acids, and proteins, providing a foundational understanding for their roles in industrial applications and health care.
2	**Vertical :**	Major
3	**Type :**	Theory
4	**Credits :**	2 credits
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Gain a thorough grasp of biotechnology, exploring its definition, historical context, and applications in various sectors, fostering a broad knowledge base. CO 2. Analyze the scope and significance of biotechnology globally and in India, evaluating its potential, achievements, and impact on the burgeoning biotech market, while understanding policy initiatives and trends. CO 3. Develop ethical awareness by examining legal and social-ethical issues in biotechnology CO 4. Grasp the definition, biological functions, and classification of Biomolecules.	
8	**Course Outcomes (OC):** Learner will be able to OC 1. articulate a comprehensive understanding of the diverse applications of biotechnology, including its historical context, global significance, and specific domains such as pharmaceuticals, plant and animal biotechnology. OC 2. develop the ability to analyze the scope of biotechnology in India, OC 3. apply their knowledge to identify potential areas of biotechnological research in India OC 4. classify, compare, explain biomolecules and their role in industry and health care.	
9	**Modules:-** **Module 1: What is Biotechnology**	
	1. Introduction to Biotechnology Definition; History & Introduction to Biotechnology Scope and Significance of Biotechnology in modern world **(3 Lectures)** **2. World of Biotechnology** Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Environmental Biotechnology. **(5 Lectures)**	

	3. Scope of Biotechnology in India Needs for future development, Global scenario, Potential and achievements of Biotechnology. Bio-business in India, booming biotech market, success story of biotech market, policy initiatives and global trends; Biotechnology research in India **(5 Lectures)** **4. Legal, Social-ethical issues (2 Lectures)**	
	Module 2: Biomolecules	
	1. **Carbohydrates:** Introduction, definition, general formula & Properties. Classification of carbohydrates, Concept of glycosidic bond, Industrial applications of carbohydrates: Fermentation, Pharmaceutical and Food industry **(6 Lectures)** 2. **Introduction to Lipid Chemistry:** Definition and Biological functions of fats and Lipids. Definition of Fatty acids. Classification of Fatty acids **(4 Lectures)** 3. **Amino acids:** General introduction, Classification and structures, properties (physical & chemical), Peptide bond, Three-dimensional Structure of proteins. **(5 Lectures)**	
10	**Text Books** 1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing. 2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing. 3. Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers 4. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.	
11	**Reference Books** 1. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman. 2. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons.	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%** **(Refer format of Question paper Below)** (Refer format of Question paper)
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

Course II

Name of the Course: Microbial Biotechnology

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This Course provides a foundational understanding of the microbial world, spanning history, microscopy, and cultivation, with a focus on sterilization techniques and bioprocess technology. Relevant across biology, chemistry, and engineering disciplines, these modules meet industry demands in pharmaceuticals, biotechnology, and healthcare, offering diverse job prospects in research, development, and production. The practical application of theoretical concepts ensures learners are well-prepared for dynamic roles in advancing microbial science and bioprocessing.
2	**Vertical :**	Major
3	**Type :**	Theory
4	**Credits :**	2 credits
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Develop a comprehensive understanding of microbial science by exploring the history, classification, and cultivation techniques, emphasizing the role of microorganisms in everyday life. CO 2. Acquire proficiency in microscopy principles, including optics, staining techniques, and the application of microscopes, laying the groundwork for practical applications in research and laboratory settings. CO 3. Discuss the principles and techniques of sterilization and disinfection, with a focus on dry heat, steam, radiation, chemical agents, and their applications in diverse settings. CO 4. Introduction to fundamentals of bioprocess technology, encompassing bioreactor design, microbial fermentations, and the industrial production of chemicals, antibiotics, enzymes, and beverages.	
8	**Course Outcomes (OC):** Learner will be able to OC 1. comprehend the microbial world's historical context, classification, and cultivation techniques, fostering a foundational knowledge base for future scientific endeavors. OC 2. Apply microscopy principles effectively, showcasing proficiency in optics, staining techniques, and practical applications, enhancing skills crucial for research and laboratory work. OC 3. Execute sterilization and disinfection techniques with precision, showcasing expertise in dry heat, steam, radiation, and chemical agents, ensuring a sound understanding of their applications across various fields. OC 4. Understand the basics of bioprocess technology, including the design of bioreactors and the industrial production of chemicals, antibiotics, enzymes, and beverages, preparing learners for roles in bioprocessing industries. OC 5. Evaluate and analyze the effectiveness of disinfectants, demonstrating critical thinking skills essential for selecting appropriate methods in healthcare, industry, and research settings, contributing to informed decision-making in real-world applications.	
9	**Modules:-** **Module 1: Introduction to Microbial World**	

	1. **History:** Discovery of Microorganisms, Role of microorganisms in everyday life. Groups of Microorganisms. **(2 Lectures)** 2. **Microscopy:** General principles of optics; various parts and their functions - objectives – numerical aperture, resolving power, depth of focus, working distance, aberrations; oculars; condensers. Applications of microscopes.Dark Field Microscope; Phase Contrast Microscope and Fluorescent Microscope **(7 Lectures)** 3. **Stains and Staining Solutions**- Definition of Dye and Chromogen; acidic and basic dyes; functions and types of chromophore and auxochrome groups. Theories to explain staining. Definition and function of stain; mordant, intensifiers and fixative. **(3 Lectures)** Natural and Synthetic Dyes. **(1 Lectures)** Simple Staining, Differential Staining – Gram staining and Acid Fast Staining with specific examples **(2 Lectures)**	
	Module 2: Sterilisation Techniques & Bioprocess Technology	
	1. **Introduction:** Definition and concept of Sterilization and Disinfection. **(1 Lectures)** **Types and Applications:** Dry Heat, Steam under pressure Gases, Radiation and Filtration **(2 Lectures)** **Chemical Agents and their Mode of Action:** Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents. **(2 Lectures)** **Disinfectant:** Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant **(2 Lectures)** 2. **Cultivation:**Nutritional categories of microorganisms, Design and Types of Culture Media, Concept of Pure culture, Methods of isolation,growth kinetics **(3 Lectures)** 3. **BioprocessTechnology:** Definition, Design of Bioreactor, Applications of Bioprocess Technology **(2 Lectures)** 4. **Microbial Fermentations**: Overview of Industrial Production of Chemicals using suitable examples, Antibiotics, Enzymes and Beverages **(3 Lectures)**	
10	**Text Books** 1. Pelczar., Microbiology. (1993). India: McGraw-Hill Education. 2. Ananthanarayan, R., Paniker, C. J. (2006). Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Longman. 3. Salle, A. J., & Salle, A. J. (1954). Fundamental principles of bacteriology McGraw-Hill. 4. Industrial Microbiology- A. H. Patel 5. A Handbook of Elementary Microbiology- H A Modi	
11	**Reference Books** **1.** Prescott, L. M. (2002). Microbiology 5th Edition. 2. Frobisher M. Fundamentals of Microbiology (9th Ed) 3. Industrial Microbiology- L. E. Casida- John Wiley & Sons	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%** **(Refer format of the Question paper)**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

Course III

Name of the Course: Practicals

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This course aims to give hands-on training in to gain laboratory skills and expertise in recent biotechnological advancements through experiments, case studies, demonstrations, and virtual visits, thus linking theory with practical insights. Acquire essential skills in microscopy, staining, sterilization, isolation, and identification, meeting industry demands for qualified professionals. Enhance employability with hands-on experience in diverse biotech applications, positioning for a dynamic and evolving industry.
2	**Vertical :**	Major
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Analyze and report on recent biotech applications to demonstrate understanding and application of theoretical knowledge. CO 2. Acquire proficiency in microscopy, staining, and sterilization for effective handling of biotechnological processes. CO 3. Conduct virtual visits to research institutes, fostering skills in navigating and extracting valuable information from scientific resources. CO 4. Apply Bergey's manual and colony characteristics to identify microorganisms, enhancing practical knowledge in microbial biology. CO 5. Gain hands-on experience in isolation techniques, microbial enumeration, and antibiotic screening, preparing for diverse roles in the biotech industry.	
8	**Course Outcomes (OC):** Learners will be able to OC 1. apply biotechnological concepts to analyze and report on recent applications in the field. OC 2. gain hands-on experience in essential lab techniques, including microscopy, staining, and sterilization, ensuring competence in practical biotech skills. OC 3. develop the ability to navigate and extract valuable information from national and international research institutes through virtual visits. OC 4. demonstrate competence in isolation, identifying microorganisms and analyzing colony characteristics using SOP's and Manuals.	
9	**Module**	
	1. Study of Microscope – Compound Microscope (Including Handling and storage) 2. Observation of microorganisms using bright field microscope - Protozoa, Molds and Yeasts, Algae – from natural habitat/permanent slides. 3. Monochrome staining using any suitable material. (Bacteria/Plant/Animal tissue) Differential staining – Gram staining, Acid fast staining, Romanowsky 4. Fungal staining – wet mount (Lactophenol cotton blue/Methylene Blue) 5. Preparation of media- Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar 6. Sterilization of Laboratory Glassware and Media using Autoclave and Hot air oven 7. Aseptic transfer of media. 8. Isolation techniques: T-streak, polygon method	

	9. Colony Characteristics of Microorganisms. 10. Use of Bergey's manual to help identify any one isolate. **(Demo)** 11. Isolation of Yeasts from the natural environment. 12. Study of morphology and colony characteristics of yeasts. 13. Enumeration of microorganisms by Serial Dilution-Pour plate, Spread plate method 14. Growth Curve of *E.coli* 15. Primary screening of antibiotic producers microorganisms from soil by crowded plate technique. 16. Qualitative estimation of carbohydrates 17. Qualitative estimation of Lipids 18. Qualitative estimation of Amino Acids/ Proteins 19. Paper Chromatography of amino acid 20. Analyse a case-study and write a report on any one recent application of Biotechnology (Not older than past 5 years) (Assignment) 21. Summarization & presentation of selected review paper not older than 5 years (under mentoring) (Assignment) 22. Field visit to National/ International research institutes for research in biotechnology (Assignment) 23. Exploring web resources of National/ International research institutes for research in biotechnology (Assignment)
10	**Text Books /Laboratory Manual** **1.** Basic Practical Microbiology - A Manual by Microbiology Society (23cbf9c5-f8c8-4f91-b092a4ad819e6357.pdf) 2. Practical Microbiology: based on the Hungarian practical notes entitled "Mikrobiológiai Laboratóriumi Gyakorlatok" by Erika M. Tóth, Andrea K. Borsodi, Tamás Felföldi, Balázs Vajna, Rita Sipos and Károly Márialigeti
11	**Reference Books** 1. Practical handbook of microbiology, 2nd Edition Eds. Emanuel Goldman, Lorrence H. Green, CRC Press, Taylor & Francis Group 2012 2. Practical Microbiology by R.C.Dubey and D.K.Maheshwari S. Chand Pub 2002 3. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India

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

VSC

VSC-1

Name of the Course: <u>Instrumentation in Biotechnology</u>

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	The course is an elementary course in instrumentation used in Biotechnology that forms the foundation of analytical techniques. The knowledge and handling of instruments is necessary in academics, research work and industry.
2	**Vertical :**	VSC
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO1 :Enable the learners to understand the principles of laboratory instruments. CO2 :Provide the practical basis for instrumentation handling and operations. CO3 :Equip the learners with the understanding of applications of the instrumentation.	
8	**Course Outcomes (OC):** Learners will be able to OC 1. understand the use and operations of basic laboratory instruments in Biotechnology OC 2. explain principle, instrumentation and applications of spectroscopic instruments. OC 3. develop skills in operating basic lab instruments	
9	**Module : Practicals 60 hr (2 credits)**	
	1. Operations, cleaning and calibration of various laboratory equipments i) Autoclave ii) Hot air oven iii) Incubator iv) shaker 2. Preparation of Normal, Molar and percentage solution (%W/W, %V/V, %W/V) 3. Calibration and accuracy of glass pipettes /micropipettes 4. Calibration of Weighing Balance, percentage error calculation 5. Preparation of standard buffers and standardization of pH meter Measurement of pH of any two samples 6. Methods of extraction and calculation of extractive yield- any 2 methods 7. Determination of Lambda max using colorimeter/spectrophotometer 8. Verification of Beer Lamberts law 9. Paper chromatography using suitable plant material 10. Paper chromatography of amino acids using ninhydrin 11. Thin layer chromatography with suitable material 12. Principle, working and applications of Centrifuge	

10	**Text Books** 1. Biophysical chemistry: Principles and Techniques (2016) Himalaya Publishing House 2. College Physical and Analytical Chemistry,(2014)K.B.Baliga, S.A.Zaveri,Himalaya Publishing House.	
11	**Reference Books** 1. Fundamentals of Analytical Chemistry(2022)10th edition -Douglas Skoog, Donald West, Cengage Technology Edition 2. Biophysical chemistry: Principles and Techniques (2016) Himalaya Publishing House 3. A practical book on calibration of Analytical Instruments (2019), Dr. Suresh Jain, Dr. Vipin Saini, Dr. Naitikkumar Trivedi, Nirali Prakashan	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60% (Refer format of Question paper)**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

VSC-2

Name of the Course: Computers in Biology

Sr.No.	Heading	Particulars
1	**Description the course : Including but not limited to:**	This course is designed for learners to gain computation skills and relate its application in biological sciences. It will introduce learners to the foundation of computers and biological databases. The practical component will help learners to gain hand-on skills in Ms-Excel and use it for biological data analysis.
2	**Vertical :**	VSC
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Develop proficiency in creating and managing biological databases using MS Excel, including data organization, formatting, and analysis. CO 2. Explore recent advances in computational biology CO 3. Establish a strong foundation for interdisciplinary work, connecting computational biology with data science and bioinformatics.	
8	**Course Outcomes (OC):** Learner will be able to OC 1. create and manage biological databases effectively using MS word, MS Excel, and Powerpoint demonstrating proficiency in data organization and analysis. OC 2. Understand and implement recent advances in computational biology OC 3. Demonstrate practical problem-solving skills by comparing and applying MS-Excel tools.	
9	**Module : Practical (2 credits)**	
	1. An Introduction to Data Types and Sources in Computational Biology(Assignment) 2. File handling: copy, rename, delete, type and Directory structure: make, rename, move directory 3. Word Processing: a. Creating, Saving & Operating a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text. b. Find & Replace, Spell Checker & Grammar Checker, c. Document Enhancement (Borders, Shading, Header, Footer), d. Printing document (Page layout, Margins), e. Working with Graphics (Word Art), Working with Tables & Charts, Inserting Files (Pictures, Databases, Spreadsheets) 4. Worksheet Basics: Entering information in a Worksheet, Saving & Opening a Worksheet, Editing, Copying & Moving data, Inserting, Deleting & Moving Columns & Rows, Clearing 5. Using formulas in spreadsheet for simple calculations 6. Creating graphs, pie charts etc in 7. Present analysis of data in Excel in graphical form. 8. Apply basic data analysis techniques using formulas like VLOOKUP, MATCH, and INDEX. 9. Creation of Computer Presentations with graphics: a. Creation of slides, changing layout and using the design tab. b. Using the insert tab function for pictures, audio, video, shapes, smart art, wordart, textbox.	

	c. Assigning Transitions and animations to slides. 10. Searching/Surfing on the internet 11. Visit to NCBI, EMBL, DDBJ, PIR, KEGG databases 12. Case studies: How databases support genomics, proteomics, and systems biology
10	**Text Books** 1. Sinha, P. K., Sinha, P. (2004). Computer Fundamentals. India: BPB Publications. 2. Goel, A. (2010). Computer Fundamentals. India: Pearson Education. 3. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley.
11	**Reference Books** 1. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, N. Mendiritta, P. Rastogi, S. C. Rastogi

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

SEC

SEC-1

Name of the Course: Microbial Techniques

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This course emphasizes biosafety, enumeration, and staining techniques, with practical application of concepts that are relevant to various fields and in demand in the industry. The course enhances students' understanding and essential skills about techniques in microbiology ,and prepares them for job prospects in research, teaching, and industry.
2	**Vertical :**	Skill Enhancement
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	~~100~~ 50 Marks
7	**Course Objectives(CO):** (List the course objectives) CO 1. To develop essential skills in microbial techniques and lay the groundwork for more advanced studies in microbiology. CO 2. To demonstrate methods for isolating and quantifying microorganisms from various sources, emphasising on aseptic techniques and proper handling. CO 3. To improve microscopic handling and understand different staining techniques for identifying different microorganisms. CO 4. To develop skills in maintaining accurate laboratory records, including microscopic observations, procedures and results.	
8	**Course Outcomes (OC):** learners will be able to OC 1. employ skills in microbial techniques for more advanced studies in microbiology.. OC 2. isolate and quantify microorganisms from various sources using aseptic techniques. OC 3. perform and examine different staining techniques for identifying different microorganisms OC 4. maintain accurate laboratory records, including observations, procedures, and results.	
9	**Module:1**	
	1. Good laboratory practices in microbiology laboratory and Biosafety measures. 2. Enumeration of microorganisms by Breed’s count method/using counting chambers. 3. Observation of cell motility in different microorganisms - bacteria, algae, paramecium by wet mount method/hanging drop method /swarming growth method. 4. Staining of spirochetes from tooth tartar. 5. Special staining: Endospores staining/Capsule Staining/cell wall staining 6. Study of the effect of different A) Physical factors like pH, temperature B) Chemical factors like Sodium Chloride, heavy metals (oligodynamic action) on growth of *E.coli.* 7. Qualitative detection of microbial enzymes like catalase, amylase, protease, lipase, dehydrogenase.	

	8. Enrichment and isolation of halophilic bacteria from marine environments. 9. Study of the effect of washing skin with soap and disinfectants on its microflora. 10. Isolation of different fungal species from spoiled fruit/vegetable samples. 11. Comparative microscopic study of microflora from different fermented foods.	
10	**Text Books** **1. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010,** **2. Biosafety in Microbiological and Biomedical Laboratories-CDC** **3. LABORATORY BIOSAFETY MANUAL FOURTH EDITION-WHO**	
11	**Reference Books** **1. Basic Practical Microbiology A manual, Published by the Society for General Microbiology, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG, UK** **2. Forbes B. A, et al: Baily and Scotts: Diagnostic Microbiology 12th Edition.** **3. Ochei J and Kolhatkar (2000); Medical Laboratory Science, Theory and Practice, Tata McGraw-Hill Publishing Company** **4. Biochemical Methods.1st , (1995), S. Sadashivam, A.Manickam, New Age International Publishers, India**	
12	**Internal Continuous Assessment: 50%**	**Semester End Examination: 50%**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	
14	**Format of Question Paper:**	

SEC-2

Name of the Course: Clinical Biochemistry

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	The practical syllabus covers tests for diabetes, cholesterol, liver and kidney function, and urine analysis. It is essential for healthcare professionals, offering skills in interpreting test results for patient care. With high industry demand, it enhances job prospects in diagnostic labs and clinical settings.
2	**Vertical :**	Skill Enhancement
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	~~100~~ 50 Marks
7	**Course Objectives(CO):** (List the course objectives) CO 1. Understand proper techniques for collecting and handling serum and urine samples to maintain their integrity. CO 2. Emphasize safety protocols and procedures specific to handling serum and urine samples, including the use of personal protective equipment. CO 3. Familiarize learners with the laboratory equipment used for analyzing serum and urine samples, such as spectrophotometers CO 4. Develop proficiency in basic laboratory techniques for processing serum and urine samples, including centrifugation, pipetting, and dilution. CO 5. Learn methods for analyzing biochemical components in serum, including tests for glucose, cholesterol, enzymes, and electrolytes. CO 6. Implement and understand quality control measures to ensure the accuracy and reliability of results in serum and urine analysis. CO 7. Develop skills in interpreting results obtained from serum and urine analyses, considering normal reference ranges and clinical significance.	
8	**Course Outcomes (OC):** (List the course outcomes) Upon completion of this course, learner will be able to OC 1. Exhibit adherence to safety protocols when handling blood and urine samples, emphasizing the importance of protecting both the laboratory personnel and the samples. OC 2. Accurately conduct analysis of biological samples OC 3. Execute fundamental laboratory techniques including centrifugation, pipetting,etc OC 4. Demonstrate the ability to interpret and analyze laboratory results, considering normal reference ranges and clinical implications for both blood and urine samples.	
9	**Modules:-Clinical Biochemistry** **Module 1:**	
	1. Determination of blood glucose for detection of diabetes mellitus. 2. Determination of serum cholesterol (total HDL and LDL ratio). 3. Determination of lactate dehydrogenase (LDH) activity in blood serum. 4. Liver function tests: (SGPT, SGOT)	

	5. Kidney function test: (Urea from serum) 6. Estimation of uric acid and creatinine in urine. 7. Quantitative detection of ketone body in urine. 8. Detection of glucose in urine (Benedict &Fehling's Test) 9. Analysis of urine for normal inorganic constituents (chlorides/phosphates/sulfates/ammonia)	
10	**Text Books** **1. Textbook of Medical Laboratory technology, Praful B. Godkar and Darshan P. Godkar,Bhalani Publishing House,2003 ISBN, 8185578583, 9788185578583** **2. Textbook of Biochemistry with clinical correlations,7th Edition, Thomas M.Delvin. 2010** **3. A manual of laboratory and diagnostic tests. Authors: Frances Talaska Fischbach, Marshall Barnett Dunning.** **4. Laboratory Reference by Jane Roskams and Linda Rodger, published by Cold Spring Harbor Laboratory Press.** **5. Medical Laboratory Technology-Volume I, Kanai Mukherjee** **6. Medical Laboratory Technology-Volume II, Kanai Mukherjee** **7. Medical Laboratory Technology-Volume III, Kanai Mukherjee**	
11	**Reference Books** **1. Practical Biochemistry & clinical Pathology, S.R.Kale,R.R.Kale,Nirali Prakashan,2020,29th Edition** **2. Biochemical Methods S. Sadashivam, A.Manickam (1995),New age International Publishers**	
12	**Internal Continuous Assessment: 50%**	**Semester End Examination: 50%**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	
14	**Format of Question Paper:**	

Semester II

Course I:

Name of the Course: Fundamentals of biotechnology-II

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This Course Aims to introduce genetic engineering essentials, covering cloning, enzymes, vectors, and host cells. The course also explores biotechnology applications in agriculture, animal and human welfare, and environmental solutions. This will develop learners to gain competencies in the vast field of gene manipulation and helps understand the approach to designing solutions.
2	**Vertical :**	Major
3	**Type :**	Theory
4	**Credits :**	2 credits
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Understand the basic steps in gene cloning techniques. CO 2. Explore diverse biotechnological applications, from GM fruits to environmental pollution abatement, gaining practical insights. CO 3. Develop skills in identifying recombinant clones and introducing vectors into both prokaryotic and eukaryotic host cells. CO 4. Understand the role of biotechnology in agriculture, animal science, and human welfare, emphasizing real-world applications.	
8	**Course Outcomes (OC):** Learner will be able to OC 1. grasp the principles of gene cloning, showcasing a conceptual understanding of genetic material manipulation. OC 2. analyze the conceptual frameworks of biotechnology, applying theoretical knowledge to address challenges in agriculture, health, and the environment. OC 3. comprehend identifying and characterizing recombinant clones, emphasizing the conceptual foundations of genetic engineering. OC 4. acquire an understanding of the theoretical underpinnings of biotechnology's role in shaping agricultural practices, animal science, and human health.	
9	**Modules:-** **Module 1:Introduction to Genetic Engineering** **1. What is Genetic engineering:** Definition and developments, gene cloning, Steps for cloning **(2 Lectures)** **2. Enzymes in genetic engineering:** Restriction endonuclease; DNA ligase; Enzymes to modify ends of DNA molecules - exonuclease; endonuclease; S1 nuclease; alkaline phosphatase; polynucleotide kinase; DNA polymerase and klenow fragment; reverse transcriptase; terminal deoxynucleotidyl transferase **(3 Lectures)** **3. Vectors:** Role as agents of transfer, Features of plasmid vectors, Plasmid vectors - pBR322, pUC etc. **(4 Lectures)** **4. Host cells:** E. coli; Bacillus subtilis; Saccharomyces cerevisiae; Xenopus oocytes; Mammalian fertilized egg cell **(3 Lectures)** **5. Introducing vector into host:** Prokaryote, Eukaryote, Identification of recombinant clones. **(3 Lectures)**	

	Module 2: Applications of biotechnology **1. Agriculture:** GM fruits- GM papaya, GM tomato, Insect resistant transgenic plants – Bt cotton, Bt brinjal, Modifications in nutrient quality – starch, oilseed protein, golden rice **(4 Lectures)** **2. Animal Biotechnology:** Growth, disease resistance, product quality, pharmaceuticals and nutritional supplements, industrial applications **(4 Lectures)** **3. Human welfare:** Cloned genes for production of -Insulin; recombinant vaccine for Hepatitis B virus. Molecular farming, Edible vaccines and their advantages **(5 Lectures)** **4. Environment Pollution:** Role of Biotechnology in control of pollution **(2 Lectures)**	
10	**Text Books** 1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing. 2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing. 3. Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers.	
11	**Reference Books** 1. Nicholl, D. S. T. (2002). An Introduction to Genetic Engineering (Studies in Biology). India: Cambridge University Press. 2. Brown, T. A. (2013). Gene Cloning and DNA Analysis: An Introduction. Germany: Wiley. 3. Genetic Engineering: Principles and Practice. (n.d.). India: McGraw-Hill Education. 4. Principles of Gene Manipulation and Genomics - Richard M Twyman and S. B. Primrose 5. Molecular Biotechnology - Principles and Applications of Recombinant DNA - Bernard R. Glick, Jack J. Pasternak	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%** **(Refer format of the Question paper Below)**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

Course II

Name of the Course: Molecular Biology & Molecular Genetics

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This course aims to develop insights in the field of molecular biology and molecular genetics to match with the pace of evolving molecular studies in biological systems. This course will enable learners to comprehend and apply tools in molecular biology and genetics. Both modules molecular biology and genetics will offer understanding of valuable skills to learners and make them competent for industries seeking professionals and develop interest in research and development in biotechnology.
2	**Vertical :**	Major
3	**Type :**	Theory
4	**Credits :**	2 credits
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Understand the structure and function of DNA and RNA, along with chromosomal organization, to grasp fundamental genetic principles. CO 2. Explore deviations from Mendelian genetic principles, environmental influences on gene expression, and analyze human genetic traits through pedigree analysis. CO 3. Comprehend models of DNA replication, including evidence of semi-conservative replication and the role of enzymes in both prokaryotic and eukaryotic systems. CO 4. Apply knowledge of genetic concepts to interpret and analyze experimental evidence, such as Messelhson and Stahl's experiment, and understand the bidirectional and rolling circle replication mechanisms.	
8	**Course Outcomes (OC):** Learners will be able to OC 1. describe the structure of DNA and RNA, explaining their roles in genetic processes. OC 2. analyze genetic deviations, understand environmental impacts on gene expression, and interpret human pedigrees. OC 3. demonstrate knowledge of DNA replication models, including semi-conservative replication and the role of enzymes. OC 4. apply genetic concepts to analyze experimental evidence, connecting theory with practical understanding.	
9	**Modules:-** **Module 1:Nucleic acid, Chromosome and Genetics** **1. The Composition and structure of DNA and RNA** Nucleotide and nucleoside, Structure of nucleotides, Structure of DNA, DNA double helix, Watson and Crick's model, Structure of RNA, Types of RNA **(3 Lectures)** **2.** Prokaryotic and Eukaryotic Chromosome, Euchromatin and Heterochromatin **(2 Lectures)** **3. Extensions of and Deviations from Mendelian Genetic Principles:** Multiple Alleles, Incomplete Dominance and Codominance Essential Genes and Lethal Alleles. Effects of the environment on Gene expression **(5 Lectures)** **4. Gene Interactions and Modified Mendelian Ratios:** Epistatic and non-epistatic interactions **(3 Lectures)** **5. Mendelian Genetics in Humans:** Pedigree Analysis Examples of Human Genetic Traits **(2 Lectures)**	

	Module 2: Replication of DNA **1. Models of DNA Replication (1 Lectures)** **2. DNA Replication in Prokaryotes (3 Lectures)** Evidence of Semi-conservative DNA replication- Messelhson and stahl's experiment **(2 Lectures)** DNA Polymerases and its role**, (1 Lectures)** E.coli Chromosome Replication**, (1 Lectures)** semi discontinuous replication, pulse chase experiment by R Okazaki **(1 Lectures)** Bidirectional Replication of Circular DNA molecules, Rolling Circle Replication, theta model of replication **(2 Lectures)** **3. DNA Replication in Eukaryotes-detail steps and role of telomerases (2 Lectures)** **4. Enzymes and proteins involved in DNA replication (2 Lectures)**	
10	**Text Books** 1. iGenetics – A molecular approach Peter J Russell 3rd edition 2. Cell and Molecular Biology 5th edition by Gerald Karp Karp (John Wiley and sons publications) 3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (2005) – P.S. Verma and Agarwal- S.Chand Publications 4. Principles of Genetics. E J Gardner, M J Simmons & D PeterSnustad. 8th edition. 1991. 5. Biochemistry - U Satyanarayana U. Chakrapani, (2013) 4th edition.	
11	**Reference Books** 1. Molecular Biology and Biotechnology (PB) by Shaily Goyal, S Chand Publishing 2. Elements Of Genetics- Veerbala Rastogi, Publisher: KEDAR NATH RAM NATH 3. Fundamentals of Genetics- B. D. Singh, KALYANI PUBLISHER 4. Molecular Biology of the Gene- By James D. Watson · 2004, Pearsons/ Benjamin Cummings	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%** **(Refer format of the Question paper Below)**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

Course III

Name of the Course: Practicals

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This course intends to develop essential skills to interpret and analyse problems underlying genetic principles. It offers insights into cellular processes like mitosis, meiosis thus linking theoretical principle to practical applications in genetics. It provides hands-on skills in DNA extraction, karyotyping thus meeting industry demand for genetic research and environmental solutions.
2	**Vertical :**	Major
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Understand fundamental cellular processes through hands-on exploration of mitosis, meiosis, and DNA extraction from plant materials. CO 2. Acquire skills in genetic analysis, including karyotyping and quantitative assessments of DNA and RNA. CO 3. Demonstrate practical knowledge of genetic concepts, solving problems related to Mendelian genetics and constructing pedigree charts. CO 4. Gain hands-on experience in molecular biology techniques.	
8	**Course Outcomes (OC):** Learner will be able to OC 1. explain and demonstrate the steps of mitosis and meiosis, understanding the basis of cellular division in plants. OC 2. develop practical skills in DNA extraction, qualitative/quantitative analysis. OC 3. solve problems based on genetic concepts and their practical applications OC 4. demonstrate basic techniques of molecular biology.	
9	**Modules:-** **Module 1:**	
	1. Study of mitosis from suitable plant material 2. Study of meiosis from suitable plant material/Permanent slides/Photographs 3. Study the effect of disinfectants on fomite surfaces. 4. Extraction and isolation of genomic DNA from various plant materials. 5. Purity and estimation of extracted DNA and RNA using UV-Vis Spectroscopy 6. Quantitative estimation of DNA 7. Quantitative estimation of RNA 8. Study of Karyotype - Normal male, Normal female, Down Syndrome, Klinefelter's Syndrome and Turner's Syndrome 9. Barr body identification in cells of Buccal smear. 10. Problems based on Mendelian Genetics, its modifications and gene interactions. 11. Construction of pedigree charts and analysis of Human genetic traits using Pedigree analysis. 12. Extraction and isolation of Genomic DNA from *E. coli.* 13. Separation and visualisation of DNA by Agarose gel electrophoresis (Demo) 14. Basic problems on Restriction Digestion Mapping 15. Study of ABO Blood groups in humans to understand the concept of multiple	

	alleles using data collection strategies. 16. Enzymes in Action: Exploring the Role of Restriction Endonucleases in Genetic Engineering(Assignment) 17. Role of GMO's in controlling Environmental pollutions(Assignment)	
10	**Text Books** 1. Principles of Genetics, 7th Edition D. Peter Snustad, Michael J. Simmons Publisher Wiley 2. Principles Of Genetics by Gardner E.J Publisher Wiley India	
11	**Reference Books** 1. Gene Cloning & DNA Analysis: An Introduction T A Brown Publisher Wiley-Blackwell	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%** **(Refer format of the Question paper Below)**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

VSC

VSC-1

Name of the Course: Medical Laboratory Technology

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	The course provides essential skill sets required in medical laboratories as a technician, thus preparing learners to explore career opportunities in diagnostics and healthcare.
2	**Vertical :**	VSC
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Develop proficiency in a wide range of laboratory techniques and skills necessary for medical diagnostics CO 2. Acquire new skills and procedures in haematology, microbiology, and biochemistry with the precautionary measures	
8	**Course Outcomes (OC):** Lerner will be able to OC 1. practise safety measures in a medical laboratory. OC 2. demonstrate the ability to perform a variety of laboratory procedures, including specimen collection, processing, and analysis, using appropriate techniques and equipment OC 3. perform basic haematological analyses and report the findings. OC 4. demonstrate the ability to identify and characterize microorganisms using Microbiological techniques	
9	**Modules:-** **Module: Introduction to Medical Lab technology**	
	1. Preparation of cleaning agents and techniques of cleaning of glass and plastic ware. 2. Collection and safety measures in Handling of Clinical specimens for pathological analysis. 3. Physical examination of clinical samples like urine,stool, etc. 4. Microscopic examination of clinical samples like urine,stool, CSF etc. 5. Microscopic examination of a. different stages of Malarial parasite b. *Mycobacterium tuberculosis* c. *Entamoeba histolytica*. 6. Qualitative Estimation Of Normal and Abnormal urine components (protein, haemoglobin, glucose, ketone bodies, bilirubin, urobilinogen.) 7. Quantitative Estimation of blood glucose 8. Components of Blood. 9. Anticoagulants different types and preparation. 10. Separation of serum and Plasma from whole blood. 11. Differential WBC count 12. Total WBC count 13. Total RBC count 14. Haemoglobin estimation by Sahli's apparatus 15. Identification & characteristics of bacteria by i. Microscopic examination ii. Colony characteristics	

	iii. Motility demonstration methods iv. Biochemical's such as – a. Carbohydrate utilization tests b. Catalase, Oxidase, Coagulase c. Indole d. MR & VP 16. Identify the ABO Blood Group in Human.	
10	**Text Books** **1.** Medical Laboratory Technology by Kanai L Mukherjee Volume I,II and III	
11	**Reference Books** **1.** Godkar, P. B., & Godkar, D. P. (2003). *Textbook of medical laboratory technology*.	
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)	

VSC- 2

Name of the Course: <u>Basics in R with Applications in Biotechnology</u>

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	The course aims to develop basic competencies in non-tech learners to handle biological data using R as an open source software. This Course offers a foundational overview of R programming, covering data types, manipulation, functions, and probability theory. The module is designed to develop hands on practical skills in R, applicable for statistical analysis and visualization for biological data With high industry demand for R proficiency, completion opens doors to roles like data analyst, research assistant and bioinformatician.
2	**Vertical :**	VSC
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Understand the fundamentals of R programming, including data types, structures, and script writing. CO 2. Acquire practical skills in data manipulation, using vectors and data frames efficiently. CO 3. Develop proficiency in creating and interpreting graphics in R for effective data visualization. CO 4. Understand Descriptive statistics and probability theory and its applications using commands in R CO 5. Gain hands-on experience in file read/write operations, preparing for real-world data handling in various formats.	
8	**Course Outcomes (OC):** Learner will be able to OC 1. confidently write and execute R scripts, demonstrating proficiency in basic programming concepts. OC 2. manipulate data using vectors and data frames, creating subsets and performing key operations. OC 3. create compelling visualizations, including plots, charts,to represent and analyze data. OC 4. understand probability distribution (normal & binomial), and will apply concepts to real-world scenarios. OC 5. demonstrate competence in reading/writing data files in multiple formats, preparing them for practical data handling tasks in diverse settings.	
9	**Modules:-** **Module:**	
	1. Introducing R ● An overview of R ● Installation of R package ● R sessions **2. Data types and data structures in R**	

- Numbers and mathematical operations
- String handling
- Vectors
- Arrays
- Matrices
- Data frames
- Lists

3. R scripts

- Writing and executing R scripts

4. Logical statements and control loops

- Logical statements
- if else statements
- for loop
- while loop
- break statement

5. Data manipulation with vectors and data frames

- Creating subsets of vectors
- Creating subsets of data frames
- Union and intersection of vectors
- Computing the differences between elements of a vector
- Cumulative sum and product of vector elements
- Finding Unique elements of a vector
- Finding duplicate elements of a vector
- Creating a frequency table
- Getting the index of a vector element
- Joining data frames
- Merging data frames

6. Functions in R

- Writing user defined functions
- Handling functions, libraries and packages

7. Data description

- Data types
- Parent populations and samples
- Statistical parameters - Mean (arithmetic), Median
- Range
- Variance
- Standard deviation
- Mode
- Percentiles and quartiles
- Skewness
- Kurtosis

8. Graphics in R

- Overview
- Plotting points and lines with plot() function
- Plotting a math function
- 2D scatter plots
- Histograms
- Bar charts
- Pie charts
- Box and whisker plots for statistical parameters
- Multiple curves on the same plot
- Multiple plots on the same page
- Drawing inside plots - low level graphics
- 3D Scatter plots

	● 3D histograms ● 3D surface plots ● Contour plots ● Plotting images ● Saving plots as image files **9. Probability Distributions** ● Concept of probability distribution ● Normal distribution ● Binomial distribution **10. File read/write** ● Read/Write tables in txt, csv and excel formats	
10	**Text Books** **1. http://www.countbio.com/** **2. https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf** **3. https://r4ds.had.co.nz** **4. https://education.rstudio.com/learn/beginner/**	
11	**Reference Books** 1. R for Beginners Emmanuel Paradis 2. Hands-On Programming with R - Garrett Grolemund 3. The Undergraduate Guide to R 4. A beginner's introduction to the R programming language -Trevor Martin 5. The Book of R- A First Course in Programming and Statistics-Tilman M. Davies 6. Basics in R with Applications in Biotechnology Getting Started with R An Introduction for Biologists ANDREW P. BECKERMAN & OWEN L. PETCHEY Publisher Oxford University Press 7. Biostatistics with R: An Introductory Guide for Field Biologists Jan Lepš, Petr Šmilauer · 2020 Publisher Cambridge University Press **8.** The New Statistics with R: An Introduction for Biologists Andy Hector · 2015 Publisher Oxford University Press	
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)	

SEC

SEC-1

Name of the Course: Physicochemical Analysis of Soil and Water

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	The course aims to introduce the fundamentals of soil and water analysis. The learner will be able to develop basic understanding of different routinely used physicochemical parameters for soil and water testing. These qualitative and quantitative tests will emphasize the relevance and application in determining the quality of soil and water.
2	**Vertical :**	Skill Enhancement
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. To create awareness about a clean environment. CO 2. To inculcate scientific temperament among the learners to understand environmental and agricultural issues. CO 3. Train the learner to determine the quality of soil and water. CO 4. To create awareness about soil and wastewater treatment processes. CO 5. To understand land use, environmental awareness and its conservation	
8	**Course Outcomes (OC):** Upon completion of this course, learners will be able to: OC 1. Understand the impact of environmental pollution on agriculture. OC 2. Determine physical and chemical properties of soil and water. OC 3. Understand the role of soil and water in agriculture. OC 4. Handle basic instruments and chemical reagents used in the soil and water testing laboratory. OC 5. Perform various tests for analysis of soil and water. OC 6. Understand how to improve the quality of soil and water by using suitable treatment methods.	
9	**Modules:-** **Module 1: soil and water analysis**	
	1. Determination the types of soil 2. Determination of pH of Soil Sample.- pH meter, pH paper and universal indicator 3. Determination of Electrical Conductivity of Soil Sample 4. Determination of available Nitrate from Soil/ water Sample. 5. Determination of Moisture content of Soil Sample 6. Determination of available Phosphate from soil sample. 7. Determination of Organic Carbon from soil sample 8. Determination of pH and Electrical Conductivity of water sample 9. Determination of Total Alkalinity of Water sample 10. Determination of Acidity of Water sample 11. Determination of total hardness soil and water sample 12. Determination of salinity of the water sample 13. Determination of Dissolved oxygen of water sample 14. Determination of TS, TSS, TDS of water sample	
10	**Text Books**	

	1. Chemical and Biological Methods for Water Pollution Studies- R.K. Trivedy, P.K. Goel, . E.M. publications	
11	**Reference Books** **1. Manual and Standard Methods for the Examination of Water and Wastewater- APHA(The American Public Health Association)** **2. Manual on soil, plant and water analysis- Dhyan Singh, P.K. Chhonkar and B.S. Dwivedi. Westville publishing house, New Delhi**	
12	**Internal Continuous Assessment: 50%**	**Semester End Examination: 50%**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	
14	**Format of Question Paper:**	

SEC- 2

Name of the Course: Food Adulteration

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This syllabus introduces the critical topic of food adulteration, highlighting its relevance in ensuring food safety and public health. Through practical applications and theoretical insights, students learn to identify, prevent, and address food adulteration
2	**Vertical :**	Skill enhancement
3	**Type :**	Practical
4	**Credits :**	2 credits
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	100 Marks
7	**Course Objectives(CO):** (List the course objectives) CO 1. Understand the Concept of Food Adulteration: Define and comprehend the various forms of food adulteration, including intentional and unintentional contamination. CO 2. Identify Common Adulterants: Learn to recognize commonly used adulterants in different food products and understand their potential health hazards. CO 3. Analytical Techniques: Acquire knowledge of analytical methods and techniques used to detect and quantify adulterants in food	
8	**Course Outcomes (OC):** (List the course outcomes) On completion of the course, learners should OC 1. Be able to identify and detect various forms of food adulteration using appropriate analytical techniques. OC 2. Develop the ability to assess the potential health risks associated with adulterated food.	
9	**Modules:-** **Module 1:**	
	1. Concept & types of adulteration, health hazards associated with adulteration 2. Organoleptic testing of food samples 3. Test for adulterants in milk & milk products 4. Detection of adulterants in i) oil & fats ii) sweetening agents iii)food grains iv) pulses and dals v) spices and condiments 5. Detection of common adulterants in miscellaneous products like saffron, common/iodized salt, tea, coffee, vinegar, green peas, pan masala, apples.	
10	**Text Books** **1. Food Adulteration and Its Detection" by S. Sukumar. New Age International (P) Limited** **2. Food Adulteration: Incidents and Measures" by Ashish Kumar Singh.CRC Press.**	
11	**Reference Books** **1. DART-Detect adulteration with rapid test -FSSAI**	

12	**Internal Continuous Assessment: 50%**	**Semester End Examination: 50%**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	
14	**Format of Question Paper:**	

Signatures of Team Members

SR.No.	Name	Signature
1.	Prof Varsha Kelkar Mane	
2.	Dr Bhupendra Pushkar	
3.	Dr Seema Kokitkar	
4.	Dr Subi Yusuf	
5.	Dr Norine D'souza	

Subcommittee members

SR. No.	Name	Name of college
1.	Dr. Rohan Gavankar	VIVA College, Virar west
2.	Dr.Shilpa Makarand Gharat	Sonopant Dandekar College, Palghar
3.	Dr Bhuvaneshwari Krishna	Smt. CHM College, Ulhasnagar
4.	Mr. Chetan Ramesh Patil	R.D. And S.H. National College and S.W.A. Science College
5.	Dr.Shailaja Puneeth Palan	Sonopant Dandekar College, Palghar
6.	Dr Sonal Upadhyay	Vikas College of Arts, Science & Commerce
7.	Mrs. Vaishalee Suryahas Chaudhari	N.B. Mehta Science College, Bordi
8.	Dr.Mukesh Ramesh Pimpliskar	G.M.Momin Womens College, Bhiwandi
9.	Mrs Swati Lomate	VIVA College, Virar west
10	Dr. Shobha Gupta	Annasaheb Vartak College of Arts, Commerce, Science

Appendix B

Justification for B.Sc. (Biotechnology)

1.	Necessity for starting the course:	A multidisciplinary field that integrates biological sciences with technology. its emerging applications in diagnostics and therapeutics, food and environment have made the subject essential for learners
2.	Whether the UGC has recommended the course:	**Yes**
3.	Whether all the courses have commenced from the academic year 2024-25	**Yes**
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	self-financed, permanent faculties are available and some faculties are on contractual basis. Visiting faculties are available for specialism
5.	To give details regarding the duration of the Course and is it possible to compress the course?:	**Course duration-** 3 years- B.Sc. (Biotechnology) 4 years- B.Sc. (Hons.) in Biotechnology completion of one year will confer certificate in biotechnology, completion of two years will yield diploma
6.	The intake capacity of each course and no. of admissions given in the current academic year:	As per sanctioned intake of the college
7.	Opportunities of Employability / Employment available after undertaking these courses:	Research positions in Institutes and managerial positions in healthcare, personal care industry, Faculty in colleges, schools, scientific writer, scientific assistant/officer/ medical representatives/ entrepreneurs, etc.

Sd/-

Sign of the BOS Chairman
Dr. Varsha Kelkar-Mane
Ad-hoc BoS in (Biotechnology)

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Ad-hoc BoS Faculty of Science & Technology

Sign of the Offg. Dean Prof. Shivram S. Garje Faculty of Science & Technology