SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: MICROBIOLOGY

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027)

Under Uniform NEP 2020

SYLLABUS

Semester I and II

Semester III and IV

Semester V and VI

Table of Contents

Preamble

Microbiology is a dynamic and interdisciplinary branch of life sciences that deals with the study of microorganisms including bacteria, archaea, fungi, algae, protozoa, viruses, and other microbial entities. Microorganisms play essential roles in maintaining ecological balance, nutrient cycling, human and animal health, agriculture, food production, environmental management, and industrial processes. The field of microbiology has significantly contributed to the development of antibiotics, vaccines, enzymes, fermented foods, bio fertilizers, biofuels, and several other biotechnological products.

The undergraduate Microbiology programme designed as per the **National Education Policy (NEP) 2020** aims to provide students with a strong foundation in fundamental and applied aspects of microbiology through a multidisciplinary, skill-oriented, and experiential learning approach. The curriculum integrates theoretical knowledge with practical training, research aptitude, entrepreneurship, and innovation to prepare students for higher education, research, industry, and societal applications.

The programme emphasizes understanding microbial diversity, structure, physiology, genetics, molecular mechanisms, microbial interactions, and applications in medical, agricultural, environmental, food, and industrial microbiology. Practical components are designed to develop competency in microbial cultivation, identification, biochemical characterization, molecular techniques, and application-based laboratory skills.

In accordance with NEP 2020 principles, the programme promotes critical thinking, problem-solving abilities, creativity, ethical scientific practices, and the integration of emerging technologies. It encourages students to explore microbial solutions for sustainable development, including environmental protection, renewable energy generation, agricultural improvement, and development of microbial-based products.

The B.Sc. Microbiology programme aims to develop graduates with scientific knowledge, technical skills, research capability, and entrepreneurial competence, enabling them to contribute effectively to academia, healthcare, biotechnology industries, environmental sectors, and society at large.

Programme Outcomes:

Students of undergraduate general degree Programme at the time of graduation would be able to

- **PO1.** Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
- **PO2**.Effective Communication : Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
- **PO3**.Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.
- **PO4**.: Effective Citizenship : Demonstrate empathetic social concern and equity centre national development ,and the ability to act with an informed awareness of issues and participate in civil life through volunteering
- **PO5.** Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
- **PO6**. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.
- **PO7.** Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest contexts socio-technological changes.

Programme Specific Outcomes

Upon completion of the program me successfully, the students would be able to

- **PSO 1** Gain insight of Microbiology starting from history and fundamental knowledge about the microorganisms.
- **PSO 2** Acquire the skill in the use and care of basic microbiological equipment and can perform basic laboratory procedures in microbiology.
- **PSO 3** Be well-informative about the integral role of microorganisms and different branches of Microbiology.
- **PSO 4** Be acquainted with the basic concept of prokaryotes, their taxonomy, and their differentiation from eukaryotes.

Employability Potential of the Programme

Microbiology is a branch of science that deals with study of microorganisms. The microbiological study has wide range of scope ranging from basic sciences to applied sciences. Microbiological study is mainly focused on causative agents of various diseases, microorganisms of agricultural, environmental and industrial use. The production of antimicrobial drugs to cure various diseases is covered in this discipline. Here is an overview of job opportunities where microbiology students have explored and would be helpful for upcoming students as well.

Medical Microbiology refers to the use of Microbiology in the Healthcare Industry. Microbiology firms are at the heart of the Healthcare Industry, whether they're developing diagnostic kits, vaccines, biologics, pharmaceuticals, or medical gear. Microbiology fields such as Molecular Biology, Cell Biology, Recombinant Technology, and immune therapeutics benefited from the medical sector's evolution. For those interested in a career in Medical Microbiology, there are numerous career prospects in Research and Development, Pharmaceutical Companies, Hospitals, Diagnostic Centers, Manufacturing Sector of Microbiology, and Academic Sector. Many of microbiology students have joined as Microbiologist at renowned pharmaceutical companies. Microbiology students have also joined COVID-19 diagnostic laboratories across various districts, thus helping the society. Beside these students have also joined vaccine manufacturing institutions.

Previously, this field only focused with the discovery and development of small molecules (drugs), but the industry has evolved throughout time. This industry's horizon has widened. Bio pharmaceutics has added a new dimension to the industry. The use of Microbiology in drug research and discovery has always been a component of the process, but the addition of biologics as therapeutic elements has resulted in a rise of biotech

businesses in the pharmaceutical sector. To begin, consider cell-based treatments, monoclonal antibodies, vaccinations, and other medicines. In this regard microbiology students have got jobs in various pharmaceutical industries. Low crop yield, crop quality deterioration, weeds, loss of soil fertility, abiotic stress, and biotic stress are just a few of the issues that have plagued agriculture. Microorganisms are also helpful in enhancing the crop productivity. Microbiology students are entrepreneur in this field. The bio fertilizers are produced in bulk and are commercialized by few of our students. Incidentally bio fertilizers are ecofriendly.

Food Microbiology overcomes challenges in food production, processing, and preservation. The production of value-added food products are the greatest examples. Almost all food industries need pure water. The bacterial quality of water is tested by Microbiologist. Food industry provides large scope for microbiologist. Microbiology students have occupied jobs at different food industries. Microbiology always helps in introducing technology which aims to enhance the production, processing, packaging and preservation of food also.

Environmental Microbiology aims to restore the balance between nature, ecology and human interest. Bioremediation and biological intervention is only possible by the way of utilization of techniques of Microbiology. All these issues are now being addressed by using Biotech processes. Microbes like bacteria, fungi algae and plants are being used in the process of bioremediation.

Beside job opportunities in the sector of agriculture, pharmaceutical and food industries microbiology students are working as research fellow at various National Institutes. Many students are working as Assistant Professor in colleges, Laboratory Technicians at Government and private pathological laboratories.

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

- Analytical skill
- Report writing skill
- Presentation skill
- Time management
- Creative thinking
- Problem solving
- Planning
- Observational skill

Job Opportunities

After successful completion of B.Sc. in Microbiology student may continue further studies like M.Sc. in Microbiology and then Ph.D. in Microbiology and make career in research field. Students have opportunities in private as well as public sectors.

Private Sector: Microbiologist can work in quality control, quality assurance and R & D divisions of companies like- Biotech companies, pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc**.**

Public Sectors: Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Government Sector: Syllabus has been design keeping in view that students can apply for various government post filled by Maharashtra Public Service Commission (MPSC), Union Public Service Commission (UPSC), Food Corporation of India, Forensic department, Health department and Food and Drug Administration. These departments recruit successful candidates for the post of Food safety officers in food and drug administration, Assistant Chemical Analyzers in forensic laboratories of Maharashtra and other states all over India, Laboratory Technicians in Clinical pathology laboratories Health department and Food Corporation of India, Sanitary Inspectors for schools etc.

Job profiles: Microbiologist, Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, and Research Scientist etc.

Thus syllabus has been prepared anticipating the requirements of B.Sc. Microbiology students under NEP Program. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline and reflect the changing needs of the students.

THREE YEARS UNDER GRADUATE PROGRAM

B.Sc. Microbiology under FACULTY: SCIENCE AND TECHNOLOGY

Board of Studies in Biochemistry including Microbiology and Food Science

Dr. Rachana R. Pachori(Chairman) Professor and Head, Department of Microbiology, R.A. Arts, Shri M.K Commerce and Shri S.R. Rathi Science Mahavidyalaya, Washim	Dr. Anil M. Garode, Ex-Professor& Head, Rajmata Jijau Nagar, Chikhli
Dr. Vijay S. Wadhai, Professor and Head, Department of Microbiology, Sardar Patel Mahavidyalaya, Chandrapur.	Dr. Niteen Phirke, Professor and Head, P.G. Department of Microbiology, Sant Gadge Baba Amravati University, Amravati
Dr. Aarti R. Deshpande, Professor and Head, Department of Microbiology Shankarlal Khandelwal College, Akola	Dr. Dnyansagar D. Bhokare, Professor, Department of Microbiology, Shankarlal Khandelwal College, Akola
Dr. Kapil Kamble, Professor, P.G. Department of Microbiology, Sant Gadge Baba Amravati University, Amravati	Dr. Nilima Yashwantrao Bhoge Professor and Head, Department of Food Science Arts Science and Commerce College, Chikhaldara Dist. Amravati
Dr. Kshitij Navinprakash Shah, Professor, Art science and commerce College, Chikhaldara	Dr. Yamini S. Patil, Professor and Head, Department of Microbiology, Shri. D. M. Burungale Science and Arts College, Shegaon.
Dr. Swati Nilesh Zodpe Associate Professor & Head, Department of Microbiology, Shri. Shivaji College of Arts Commerce and Science Akola.	Mr. Ajit Babruwahan Patil, Assistant Professor & Head, Department of Biochemistry, Ghulam Nabi Azad Arts, Commerce and Science College, Barshitakli Dist. Akola.
Dr. Ashwini A. Balode, Assistant Professor & Head, Department of Biochemistry, Shri. Shivaji College of Arts Commerce and Science Akola.	

Credit Distribution

Three/Four-year UG Degree Programme (Level 4.5 to 5.5)

Vertical	Vertical Type	I	II		III	IV	V	VI	Total Credits	Grand Total
	(i) Three-year UG Degree Programme (Level 4.5.to 5.5									
A	**Major**	4	4	Major	6	8	8	8	38	**48**
	DSC (60–64)			IKS	2				2	
	(Minimum 50% of Total Credits)	0	0	Elective	0	0	4	4	8	
B	**Minor (from same faculty of DSC) (18–24)**	4	4		4	4	4	4	24	**24**
C	**Generic/Open Elective (OE)** (Faculty-wise basket other than Major/Minor faculty) (10–12)	4	4		2	2	0	0	12	**12**
D(i)	**Vocational Skill Courses (VSEC)** corresponding to Major/Minor (8–10)	0	2		2	2	2	2	10	**16**
D(ii)	**Skill Enhancement Courses (SEC)**	2	2		0	0	2	0	6	
E(i)	**Ability Enhancement Courses (AEC)** (English + Modern Indian Language)	1+1	1+1		1+1	1+1	0	0	8	**14**
E(ii)	**Indian Knowledge System (IKS) 2 Generic**	2	0		0	0	0	0	2	
E(iii)	**Value Education Courses (VEC)** (Understanding India, EVS, Digital & Technological Solution) 4	2	2		0	0	0	0	4	
F(i)	**Internship / Apprenticeship** corresponding to Major 8 **(OJT)**	0	0		0	0	0	4	4	**18**
F(ii)	**Field Projects / Community Engagement & Service (CEP)** corresponding to Major 4-6	0	0		2	2	2	0	6	
F(iii)	**Co-curricular Courses (CC)** (health & wellness, yoga education, sports, fitness, cultural activities, NSS/ NCC & Fine/ Applied/ Visual/ Performing Arts 8	2	2		2	2	0	0	8	
	Total Credits per Semester	**22**	**22**		**22**	**22**	**22**	**22**	**132**	**132**

(ii) Four-year UG Degree programme (Level 6.0) Honors Degree in Major or Minor A. Honors Degree in Major or Minor					
	Vertical Type			Semester VII	Semester VIII	
	Major (Offered at Three-year UG Programme)	**Mandatory**		**12-14(2*4+2*2 or 3*4+2)**	**12-14(2*4+2*2 or 3*4+2)**	**28**
		Elective		4	4	8
	Research Methodology (RM)			4	0	8
	On the Job Training (OJT)			0	4	4
	Total			**22**	**22**	**44**
	Cumulative			**(132+44) 176**		
(ii) Four-year UG Degree Programme (Level 6.0) B. Honors with Research Degree in Major or Minor						
	Major (Offered at Three-year UG Programme)			**Semester VII**	**Semester VIII**	
		Mandatory		8-10 (24+2 or 24)	8-10 (24+2 or 24)	20
		Elective		4	4	8
	Research Methodology (RM)			4	0	4
	Research Project (RP)			4	8	12
	Total			**22**	**22**	**44**
	Cumulative			**(132+44) 176**		

Teaching and Learning Scheme: for the Degree of Bachelor of Microbiology as Major
Sant Gadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY
Teaching and Learning Scheme: for the Degree of Bachelor of Microbiology as Major and as Minor

TLE SCHEME FOR FIRST YEAR: SEMESTER – I

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload Hrs/Week
Classroom Teaching / Lab Work (Practical)/ Outdoor/ Field	a.	Major Microbiology 127	Theory 1	127200	Introductory Microbiology	2	2	6
			Lab/ Practical-1	127201	Basic techniques and Study of microbes	2	4	
	b.	Major/ Minor	Theory 1	-	-	2	2	6
			Lab/ Practical-1	-	-	2	4	
	c.	Generic/ Open Elective 127	Theory 1	127202	Communicable diseases and their control	2	2	4
			Theory 2	127203	Food preservation and Food safety	2	2	
	d.	SEC	Lab/ Practical-2	127204	Microscopy and Staining for microbes	2	4	4
	e.	AEC - English	Theory		Refer University basket	1	1	6
		AEC –MIL	Theory		Refer University basket	1	1	
		IKS-Generic	Theory		Refer University basket	2	2	
		VEC	Theory		Refer University basket	2	2	
	f.	CC	Outdoor		Separate SOP will be released	2	4	4

TLE SCHEME FOR FIRST YEAR: SEMESTER – II

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor/ Field	a.	Major /Minor Microbiology 127	Theory 2	127205	Bacteriology and Microbial control	2	2	6
			Lab/ Practical 3	127206	Techniques for culturing Bacteria	2	4	
	b.	Major/ Minor	Theory 2	-	-	2	2	6
			Lab/ Practical-2	-	-	2	4	
	c.	Generic/ Open Elective 127	Theory 3	127207	Microbes for Sustainable Agriculture	2	2	4
			Theory 4	127208	Composting and Biogas Technology	2	2	
	d.	VSC	Lab/ Practical-4	127209	Microbial Control	2	4	8
		SEC	Lab/ Practical 5	127210	Isolation and Morphological Characterization of Bacteria	2	4	
	e.	AEC - English	Theory		Refer University basket	1	1	4
		AEC –MIL	Theory		Refer University basket	1	1	
		VEC	Theory		Refer University basket	2	2	
	f.	CC	Outdoor		Separate SOP will be released	2	4	4

TLE SCHEME FOR SECOND YEAR: SEMESTER – III

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload Hrs/Week
Classroom Teaching / Lab Work (Practical)/ Outdoor/ Field	a.	Major Microbiology 127	Theory 3	127211	Bacterial Growth and Pure Culture	2	2	10
			Theory 4	127212	Fundamentals of Virology	2	2	
			Lab/ Practical-6	127213	Techniques for Bacterial Growth and Pure Culture	2	4	
		IKS Major Specific	Theory	127214	IKS in Microbiology	2	2	
	b.	Minor 127	Theory 3	127215	Microbial Reproduction and Bacterial Pure Culture	2	2	6
			Lab/ Practical-3	127216	Techniques of Microbial culture, Bacterial Physiology and Pure Culture	2	4	
	c.	Generic/ Open Elective 127	Theory 5	127217	Applied Microbiology for Day to Day Life	2	2	2
	d.	VSC	Lab/ Practical -7	127218	Microbial cultivation and Culture Preservation	2	4	4
	e.	AEC - English	Theory			1	1	2
		AEC –MIL	Theory			1	1	
	f.	FP/CES	Project	127219	FP/CES in Microbiology-I	2	4	8
		CC	Outdoor			2	4	

TLE SCHEME FOR SECOND YEAR: SEMESTER – IV

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload Hrs/Week
Classroom Teaching / Lab Work (Practical)/ Field	a.	Major Microbiology 127	Theory 5	127220	Medical Microbiology	2	2	10
			Theory 6	127221	Immunology& Serology	2	2	
			Theory 7	127229	Microbiology for public health	2	2	
			Lab/ Practical-8	127222	Medical Microbiology and serology	2	4	
	b.	Minor 127	Theory 4	127223	Clinical Microbiology	2	2	6
			Lab/ Practical-4	127224	Clinical Microbiology and serology	2	4	
	c.	Generic/ Open Elective 127	Theory 6	127225	Microbiology for Human Health	2	2	2
	d.	VSC	Lab/ Practical - 9	127226	Skills for Diagnostic Microbiology	2	4	4
	g.	AEC-English	Theory			1	1	2
		AEC–MIL	Theory			1	1	
	h.	FP/CES	Project	127228	FP/CES in Microbiology–II	2	4	8
		CC	Outdoor			2	4	

TLE SCHEME FOR THIRD YEAR: SEMESTER – V

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload Hrs/Week	Vertical Workload Hrs/Week
Classroom Teaching / Lab Work (Practical)/ Outdoor/ Field	a.	Major Microbiology 127	Theory 8	127230	Microbial Ecology & Environmental Microbiology	2	2	10
			Theory 9	127231	Biochemistry & Metabolism	2	2	
			Theory 10	127232	Fundamentals of Industrial Microbiology	2	2	
			Lab/ Practical-10	127233	Biochemistry & Environmental Microbiology	2	4	
		Major Elective 127	Theory 1 DSE 1	127234	Fermentation Technology	2	2	6
			Lab/ Practical DSE 1	127235	Fermentation Technology	2	4	
			OR					
			Theory 2 DSE 2	127236	Agriculture Microbiology, Bioinstrumentation and Biostatistics	2	2	6
			Lab/ Practical-DSE 2	127237	Agriculture Microbiology, Bioinstrumentation and Biostatistics	2	4	
	b.	Minor 127	Theory 5	127238	Environmental Microbiology and Biomolecules	2	2	6
			Lab/ Practical-5	127239	Environmental Microbiology and Biomolecules	2	4	
	c.	Generic/OE	-	-	-	-	-	-
	d.	VSC	Lab/ Practical-11	127240	Water Analysis for Environmental Monitoring	2	4	8
		SEC	Lab/ Practical-12	127241	Microbial Fermentation	2	4	
	e.	VEC	-	-	-	-	-	-
	f.	FP/CES	Project	127242	FP/ CEP in Microbiology	2	4	4
		Non- credit	Non- credit	-	Foundation of Artificial intelligence	NC	2	2

TLE SCHEME FOR THIRD YEAR: SEMESTER – VI

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload Hrs/Week	Vertical Workload Hrs/Week
Classroom Teaching / Lab Work (Practical)/ Outdoor/ Field	a.	Major Microbiology 127	Theory 11	127243	Molecular Biology	2	2	10
			Theory 12	127244	Food & Dairy Microbiology	2	2	
			Theory 13	127245	Genetic Engineering	2	2	
			Lab/ Practical-13	127246	Applied Microbiology	2	4	
		Major Elective 127	Theory 3 DSE 3	127247	Fundamentals of Enzymology	2	2	06
			Lab/ Practical-DSE 3	127248	Fundamentals of Enzymology	2	4	
			OR					
			Theory 4 DSE 4	127249	Microbial Biotechnology And Entrepreneurship	2	2	06
			Lab/ Practical-DSE 4	127250	Microbial Biotechnology And Entrepreneurship	2	4	
	b.	Minor 127	Theory 6	127251	Molecular Biology & Genetic Engineering	2	2	6
			Lab/ Practical -6	127252	Molecular Biology &Genetic Engineering	2	4	
	c.	Generic/ OE	-	-	-	-	-	-
	d.	VSC	Lab/ Practical 14	127253	Quality control for Food and Dairy Products	2	4	4
	e.	VEC	-	-	-	-	-	-
	f.	Internship/ Apprenticeship	OJT	127254	Internship /Apprenticeship/ OJT (On the Job Training)	4	8	8
		FP/CES	Project	-	-	-	-	

SWAYAM/NPTEL Courses under NEP 2020

Sr. No.	SEM	Course Title	Course Code*	Credits**	Institution	Agency	Enrollment Ends	Link to Enroll
1.	I	Basics of Food and Nutrition	noc26_ge100	3	NOC-IITM	NPTEL	09 Oct 2026	https://onlinecourses.nptel.ac.in/elearning/preview/noc26_ge100
2.	II	Soil fertility and fertilizers	noc26_ag21	4	IIT, Kharagpur	NPTEL	09 Oct 2026	https://onlinecourses.nptel.ac.in/elearning/preview/noc26_ag21
3.	III	Introduction to Cell Biology	noc26_bt102	3	IISER, Pune	NPTEL	09 Oct 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt102
4.	IV	Biomedical nanotechnology	noc26_bt97	2	IIT, Roorkee	AICTE	17 Aug 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt97
5.	V	Waste water treatment & recycling	noc26_ce140	4	IIT, Kharagpur	NPTEL	14 Aug 2026	https://onlinecourses.nptel.ac.in/elearning/preview/noc26_ce140
6.	V	Environmental Biotechnology	noc26_bt88	4	IIT, Kharagpur	AICTE	09 Oct 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt88
7.	VI	Bioreactors	noc26_bt58	2	IIT, Madras	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt58

***Course codes may vary according to the year and session of enrollment**

**** Credits will be awarded as per provisions of the SWAYAM/NPTEL at the time of actual enrollment.**

Instructions for Enrollment in SWAYAM/NPTEL Courses under NEP 2020

All students of B.Sc. with Microbiology as Major or Minor of all semesters are encouraged to enroll in suitable SWAYAM/NPTEL online courses to enhance their academic knowledge, practical skills, and employability.

General Instructions

1. Students may choose any course of their interest listed in table above.
2. Before enrollment, students must ensure that they have an active Academic Bank of Credits (ABC) ID. The same ABC ID should be used while registering for the selected SWAYAM/NPTEL course so that earned credits can be deposited in the Academic Bank of Credits.
3. Students should carefully read the course details including duration, eligibility, syllabus, examination schedule, and credit structure before enrolling.
4. Merely enrolling in a course does not make a student eligible for academic credits. Students must: Complete the course requirements Appear for the proctored examination, and successfully pass the examination as per the norms prescribed by SWAYAM/NPTEL.
5. Credits will be awarded only after successful completion and certification of the course by the concerned agency.
6. Every student must submit the details of the enrolled course to the Department of Microbiology immediately after registration.
7. Submission of enrollment details to the Department is mandatory to facilitate record maintenance and compliance with University requirements regarding credit transfer and academic documentation.
8. Students are advised to preserve all course-related documents, including Enrollment confirmation, Course progress records, Examination registration receipt, Score card, Final certificate.
9. Students shall be responsible for timely registration for the examination, payment of examination fees (if applicable), and completion of all course requirements within the stipulated period.
10. The Department of Microbiology shall not be responsible for missed deadlines, incomplete registrations, examination non-appearance, or failure to satisfy the certification requirements of the concerned SWAYAM/NPTEL course.
11. After successful completion of the course, students must submit a copy of the course certificate and score card to the Department of Microbiology for further processing and reporting to the University.

Notes:

a. The strength of the batch of the Practical for UG Classes shall be 16 with an addition of 10% with the permission of Hon'ble Vice Chancellor. The number of the students required to constitute a batch or calculate the workload shall be in accordance with the relevant Government Resolution in force at the time, applicable to specific time, region, course type, mode of instruction, and other pertinent factors.

b. 1 Credit shall mean 1 Hour Teaching per Week per Semester (Total 15 Hrs/ Semester), the duration of 1 Teaching Period will be 60 Minutes. For Practical 1 Credit shall mean 2 Hour Teaching per Week per Semester (Total 30 Hrs/ Semester).

c. For Examination and Evaluation of Theory Courses, 40 % Marks shall be assigned to Internal Examination and 60% Marks shall be assigned to end-semester external university examination.

d. **Co-curricular Courses:** Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III, IV, V and VI**.** These courses may be taught by Physical Education Director or may be assigned to Language Teacher by the Principal of HEI based on the expertise of the concerned.

e. **Value Education Courses** to be selected from the Basket of Courses provided by the University. These courses may be assigned to the Language Teacher by the Principal of HEI based on the expertise of the concerned.

f. **Generic / Open Elective Courses (GE/OE):** Courses to be selected from the Basket of Courses provided by the University

g. **Abbreviations:** Department Specific Core: DSC, Department Specific Elective: DSE, FSC: Faculty Specific Core, FSE: Faculty Specific Elective, Indian Knowledge System: IKS, Inter Faculty Specific Core: IFSC, Inter Faculty Specific Elective: IFSE, Theory: Th, Practical/Practicum: Pr, Environment Studies: ES, Pre-requisite Course mandatory if applicable: Prq, Laboratory: Lab (Practical), Generic/ Open Electives: OE; Vocational Skill and Skill Enhancement Courses: VSEC; Vocational Skill Courses: VSC; Skill Enhancement Courses: SEC; Ability Enhancement Courses: AEC; Value Education Courses: VEC; OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; Community Engagement and Service: CES; Co-curricular Courses: CC; RM: Research Methodology; Research Project: RP; MIL: Modern Indian Language.

Examination and Assessment Process

i. The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

ii. Exit options are provided with Certificate, Diploma and Basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a Four Years Multidisciplinary Degree Programme. Students will receive a Bachelor's degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.

iii. For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019).

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table

Table: Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
a	Major	External & Internal	30	9	20	6	50	20	25	10	25	10	50	20
b	Minor		30	9	20	6	50	20	25	10	25	10	50	20
c	Generic/ Open Elective		30	9	20	6	50	20	--	--	--	--	--	--
d	VSC	Internal	--	--					--	--	50	20	50	20
	SEC	Internal	--	--					--	--	50	20	50	20
e	AEC (Eng. & One MIL Composite)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	IKS (Generic)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	VEC	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
f	Internship Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum 50 marks per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.											
	FP/CEP													
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

1. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).
   - First on completion of 25% Syllabus of the course or on completion of 25 teaching days.
   - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days.
   - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.
2. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.
3. Total Performance in CAT (i.e. 40 %) shall be based on the **best two out of three** in CAT examinations.
4. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule

Sr. No.	Name of the Examination	End Semester Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

***** The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.

2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.

3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.

4. Provided that the student shall be eligible to appear for examination if -

a) He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
b) He/she has prosecuted a regular course of study in a university department/college affiliated to the University.
c) He/she has in the opinion of the Principles shown satisfactory progress in his/her studies.

5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.

6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: MICROBIOLOGY

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027)
Under Uniform NEP 2020

SYLLABUS

Semester – I & II

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years- Six Semesters Bachelor's Degree Programme)

FIRST YEAR: SEMESTER – I

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major Microbiology 127	Theory-1	127200	Introductory Microbiology
		Lab/ Practical-1	127201	Basic Techniques and Study of microbes
b.	Major/ Minor	Theory-1	-	-
		Lab/ Practical-1	-	-
c.	Generic/ Open Elective 127	Theory-1	127202	Communicable Diseases and their control
		Theory-2	127203	Food Preservation and Food Safety
d.	SEC	Lab/ Practical-2	127204	Microscopy and Staining for Microbes
e.	AEC - English	Theory		
	AEC –MIL	Theory		
	IKS-Generic	Theory		
	VEC	Theory		
f.	CC	Outdoor		

Course: B. Sc. I Semester I (Microbiology)

127200 Theory: Introductory Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	I	127200	Introductory Microbiology	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives

- To make the students aware about history and modern developments in microbiology.
- To impart knowledge about scope of microbiology with its branches and applications.
- To educate the students about occurrence and general features of different types of microorganisms
- To make the students understand the principles and working of different types of microscopes and have the knowledge of staining techniques.

Course outcome

Upon completion of this course successfully, students would be able to

- Explain the historical developments in microbiology and their importance as well as application in different sectors concerned with life on this planet.
- Differentiate the microbes on the basis of their characteristics and apply the classification scheme for identification.
- Discuss the similarities and differences in structures of prokaryotic and eukaryotic cells and illustrate mutual relationship on the basis of three domain system.
- Illustrate different types of microscopes and staining techniques.

Unit System	Contents	Workload Allotted in hours	Weightage of Marks Allotted	Pedagogy
Unit I History and Development of Microbiology	➢ Discovery of Microscope- Contribution of Antony von Leeuwenhoek ➢ Controversy over Spontaneous generation: Contributions of Redi, Schulze and Schwan, Schroder & Van Dusch, Louis Pasteur ➢ Contribution of pioneers in development of Microbiology Louis Pasteur (fermentation &	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models:** use of model, Charts.

	Vaccine), Alexander Fleming (Antibiotic), Joseph Lister (Antiseptic surgery), Edward Jenner (Small pox Vaccine), Robert Koch (Germ theory of diseases, Koch postulates) ➢ Modern developments of microbiology including Immunology, Recombinant DNA technology, Biotechnology. Contributions of Watson and Crick, Jacob and Monod, ➢ Har Gobind Khorana Ruska, ➢ Kary Mullis, Temin and Baltimore, Hamilton Smith			**Problem-Solving Sessions:** Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts.
Unit II **Scope of Microbiology**	➢ Occurrence of microorganisms ➢ Scope of Microbiology in applied fields ➢ Microorganisms for human welfare ➢ Microorganisms for environment and sustainability. ➢ Detrimental activities of microorganisms ➢ Microorganisms and human diseases, Biological weapons ➢ Microorganisms and diseases of animals ➢ Microorganisms and diseases of plants ➢ Microorganisms and spoilage	7 Hrs	7 Marks	

Unit III The world of Microbes	➢ Concept of prokaryotes and eukaryotes ➢ Structural differences in prokaryotic and eukaryotic cell ➢ Types of microorganisms • Bacteria-Eubacteria and archaea • Fungi, protozoa, algae viruses ➢ Basic branches of Microbiology ➢ Woese system of 3 domain ➢ classification of microbes	8 Hrs	8 Marks	**Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable
Unit IV Microscopy and Staining	➢ **Microscopy:** ➢ Definition: Magnification, Resolving power, numerical aperture, focal length ➢ Principles, construction, ray diagram and applications: • Compound Microscope • Dark field microscope • Electron Microscope. ➢ **Staining:** ➢ Dyes and Stains-auxochromes, chromophore, mordant ➢ Principles and Methods of the following techniques: • Simple staining • Differential staining- Gram stain, Acid fast staining and Endospore staining, Capsule staining	7 Hrs	7 Marks	

References	➢ Microbiology: Pelczar, Chan, Krieg.(TMH) ➢ Text Book of Microbiology: Dubey & Maheshwari (S. Chand, Publication) ➢ Fundamental of Microbiology: Frobisher ➢ General Microbiology Vol. I & II: Pawar & Daginawala (Himalaya Publication) ➢ Fundamentals of Principles: A.J. Salle. bacteriology ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II
Model Questions	**Short Answer Questions** 1. Contribution of Antony von Leeuwenhoek 2. How will you disprove spontaneous generation explain with suitable example 3. Contribution of Schulze and Schwan 4. Contribution of Louis Pasteur in the field of fermentation 5. Contribution of pioneer in the development of antibiotics 6. Write any two applied branches of Microbiology 7. Explain any two diseases of animal caused by microorganism 8. Explain any two diseases of human caused by microorganism 9. Explain any two diseases of plants caused by microorganism 10. Illustrate the role of microorganisms for human welfare 11. Explain with suitable example how microorganisms cause spoilage? 12. Differentiate between prokaryotes and eukaryotes 13. Discuss about various types of microorganisms 14. Explain various branches of microbiology 15. Write a note on algae and fungi 16. Define resolving power and numerical aperture 17. Discuss on electron microscope 18. Give the schematic explanation about simple staining 19. Discuss any one method of differential staining 20. Give the schematic explanation about Dorner's method of endospore staining 21. Sketch ray diagram of dark field microscope 22. Differentiate between dyes and stain 23. What are the components of compound microscope 24. Explain Dyes and Stains 25. Differentiate between Simple staining and Gram staining 26. Illustrate the different parts of compound microscope

Long answer questions

1. Who disproves the spontaneous generation?
2. What was the contribution of pioneers in development of Microbiology?
3. Explain the 3 domain classification of microbes
4. With the help of labeled diagram differentiate in prokaryotes and eukaryotes
5. Discuss in detail acid fast staining
6. Discuss in detail endospore staining
7. Discuss in detail construction, ray diagram and applications of TEM
8. Explain with suitable example different applied branches of microbiology

Multiple choice Questions

1. Father of microbiology is

a. Louis Pasteur b. Lister

c. **A.V. Leeuwenhock** d. Robert Koch

2. The antiseptic method was first demonstrated by

a. Lwanowski b. **Lord Lister**

c. Edward Jenner d. Beijerinck

3. Small pox vaccine was first discovered by

a. Robert Koch b. Louis Pasteur

c. Lister d. **Edward Jenner**

4. Father of Medical Microbiology is

a. Pasteur b. Jenner

c. **Koch** d. A. L. Hock

5. Electron microscope gives magnification upto

a. 100 X b. 2000 X

c. 50,000 X d. **2,00,000 X**

6. Compound Microscope was discovered by

a. A.V. Lewenhoek b. Pasteur

c. **Janssen and Hans** d. None of these

7. Acridine dyes are more effective against

a. **Gram positive** b. Gram negative

c. Ricke Hsia d. Mycoplasma

8. The procedure of differential staining of bacteria was developed by

a. A.H. Gram b. **H.C. Gram**

c. N.C. Gram d. H.A. Gram

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		**20 Marks**

127201 Lab 1 : Basic techniques and Study of Microbes							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	I	127201	Basic Techniques and Study of Microbes	2	60	2 Hrs	25 (Ext) + 25 (Int)

Course Objectives

- To train the students for basic techniques in microbiology.
- To introduce the students with handling and working of common equipment's used in microbiology laboratory.
- To educate the students about microscopic and identifying characteristics of different types of microorganisms

Course Outcomes

Upon completion of this course successfully, students would be able to

- Work in microbiology laboratory using basic techniques and by following safety and precautionary measures.
- Apply the knowledge of media preparation and inoculation for culturing bacteria in basic nutrient media using incubator.
- Use basic laboratory instruments viz. incubator, pH meter, colorimeter and laminar air flow cabinet.
- Demonstrate basic staining technique.
- Apply the knowledge of microscopic features for identification of the microbes.

Sr. No.	**Contents of Practical (**List of Laboratory Experiments/ Activities etc.)
1.	Standard operating procedures for microbiology laboratory: Disinfection, safety measures, Glassware washing, disposal of media
2.	Basic techniques of microbiology: Petri plate wrapping, cotton plug preparation, Use of rubber bulbs and micropipettes, Swabs preparation, use of inoculating loop
3.	To study the Principles and Operation of a) Autoclave b) Oven c) Incubator d) Laminar air flow e) spectrophotometer/colorimeter f) centrifuge

4.	Study different parts of microscope
5.	Use of pH meter and Measurement of pH
6.	Simple staining of yeast
7.	Gram staining technique for bacterial culture
8.	Negative staining technique
9.	Study of bacteria using permanent slides and pictures of stained bacteria.
10.	Study of moulds using permanent slides
11.	Study of yeast using permanent slides
12.	Study of viruses using electron microscopic photographs and photographs of plaques

References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ A textbook of Practical Microbiology (B. Sc. SEM I & II): Dr. R. R. Pachori, P.S. Sadar, Dr. A. M. Pande, 2nd Edition. ➢ Microbes in Action: Seely, Wander Mark Tarporewala, Bombay ➢ A Mannual of Microbiology: A.J. Salle. ➢ Microbiology Methods: Collins ➢ Bacteriological Techniques: F.J. Baker ➢ Introduction to Microbial Techniques: Gunasekaran ➢ Laboratory Fundamentals of Microbiology: Alcamo, I.E., Jones and Bartlett Publishers. ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	Total	25 Marks

127204 SEC Lab Practical 2: Microscopy and Staining for Microbes							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	I	127204	Microscopy and Staining For Microbes	2	60 Hrs	2 Hrs	50 (Int)

Course Objectives

- To train the students for basic skills of using compound microscope for study of microorganisms.
- To impart the skill of application of staining techniques for study of microorganisms.
- To educate the students about applications of different types of microscopes.

Course Outcomes

Upon completion of this course successfully, students would be able to

- Do focusing with all the three objectives of compound microscope.
- Illustrate different types of microscopes and staining techniques.
- Apply different staining and microscopic techniques for study of microorganisms

S.N.	**Contents of Practical (**List of Laboratory Experiments/ Activities etc.)
1.	Study of compound microscope with ray diagram.
2.	Focusing with compound microscope using low power, high power and oil immersion objectives
3.	Preparation of stains and other staining solutions
4.	Simple staining of yeast cells
5.	Endospore staining by Scheffer's and Fullton's method
6.	Endospore staining by Dornor's method
7.	Acid fast staining
8.	Dark field microscopy with ray diagram
9.	Hanging drop method for motility
10.	Study of fungi using lacto phenol cotton blue staining
11.	Wet Mount of algae/algae staining
12.	Study of Electron microscope using virtual lab / Videos

References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by- S. Chand ➢ A Text book of Practical microbiology by P.S. Sadar and A.M. Pande, Ed. Rachana Pachori (Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I & II: Pawar & Daginawala (Himalaya Publication) ➢ Fundamentals of Principles: A.J. Salle. Bacteriology ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

Internal Evaluation for SEC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

127202 Theory 1 (Generic Open Elective Course) : Communicable diseases and their Control							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	I	127202	Communicable diseases and their Control	2	30	2Hrs	30 (Ext) + 20 (Int)

Course Objectives:	To understand the role of different microorganisms in disease formation To apply this knowledge to control infectious diseases.			
Course Outcomes	Upon completion of this course successfully, students would be able to 1. Acquire knowledge about vectors that transmit diseases 2. Know how the diseases spread in the community 3. Understand occurrence of symptoms in diseases 4. Know the methods of prevention of spread of diseases in community 5. Control of disease agent and hence diseases			
Unit System	**Contents**	**Workload Allotted in hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit I Water Born and Food Borne Diseases	1. Communicable diseases: Definition- Microorganisms, infection, pathogenicity, vector, communicable and non-communicable diseases, 2. Water borne diseases a. Causes, symptoms and prevention of following i. Typhoid fever ii. Cholera iii. Dysentery iv. Hepatitis- A 3. Food borne diseases a. Causes, symptoms and prevention of following v. Staphylococcus food	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding

	poisoning vi. Clostridium botulism food poisoning vii. Salmonella food poisoning 4. Control of water borne and air borne diseases			of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore Topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply
Unit II **Air borne diseases**	1. Air borne diseases a. Causes, symptoms, prevention and control of following i. Diphtheria ii. Tuberculosis iii. Pneumonia iv. Aspergillosis v. Chicken pox vi. Measles vii. Herpes	7 Hrs	7 Marks	
Unit III **Diseases transmitted through Arthropod vectors and Zoonotic diseases**	1. Arthropod vector borne diseases a. Causes, symptoms and prevention of following i. Dengue ii. Malaria iii. Yellow fever iv. Typhus fever b. Control of arthropod borne diseases c. What are zoonotic diseases i. Rabies d. Control of Zoonotic diseases	8 Hrs	8 Marks	

Unit IV Contagious Diseases	1. Contagious diseases a. Causes, symptoms and prevention of following i. Dermatophytosis 2. Control of Contagious diseases 3. Sexually transmitted diseases a. What are Sexually transmitted diseases b. Causes, symptoms and prevention of following i. HIV/AIDS ii. Gonorrhea iii. Syphilis 4. Control of sexually transmitted diseases	7 Hrs	7 Marks	theoretical knowledge. **Any other innovative pedagogy as applicable.**
Model Questions	1. Explain symptoms and prevention of Cholera 2. Explain symptoms and prevention of *S. aureus* food poisoning 3. Explain symptoms and prevention of Diptheria 4. Explain symptoms and prevention of Tuberculosis 5. Explain symptoms and prevention of Pneumonia 6. Explain symptoms and prevention of Herpes 7. Explain symptoms and prevention of Dengue 8. Explain symptoms and prevention of Typhus fever 9. What are the zoonotic diseases 10. How will you control Zoonotic diseases 11. Define sexually transmitted diseases, and explain causes and control of AIDS 12. Explain causes and control of Syphilis			

Books for Reference:

- Communicable Disease: Epidemiology and Control: Norman Noah and Mary O′Mahony
- Control of Communicable Disease: A. S. Beneson
- Controlling Communicable Disease (Understanding Public Health): Norman Noah
- Disease Control Priorities in Developing Countries (Oxford Medical Publications): Dean T Jamison
- Infectious Diseases of Humans: Dynamics and Control: Roy M Anderson and Robert M May
- Microbiology and infectious diseases by: Kenneth D. Somers, Stephen A. Morse
- Medical Bacteriology: Dey N.C. & Day T.K.
- Medical Microbiology Vol. I &II : Cruickshank K.R.
- Text Book of Microbiology : Ananthanarayan R. & C.E. Panikar
- Dorland's Pocket Medical Dictionary
- Preventive & Social Medicine : Park & Park
- Medical Microbiology : R. Anantnarayan
- Fundamental Priciplesof :A.J.Salle. Bacteriology
- Microbes & Diseases of Man: W.C. Deb.

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 base on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 test</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 base on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

127203 Theory 2 (Generic Open Elective Course) : Food Preservation and Food Safety							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	I	127203	Food Preservation and Food Safety	2	30	2Hrs	30 (Ext) + 20(Int)

Course Objectives:	To understand the role of different microorganisms in disease formation To apply this knowledge to control infectious diseases
Course Outcomes	Upon completion of this course successfully, students would be able to 1. Acquire knowledge about vectors that transmit diseases 2. Know how the diseases spread in the community 3. Understand occurrence of symptoms in diseases 4. Know the methods of prevention of spread of diseases in community 5. Control of disease agent and hence diseases

Unit System	**Contents**	**Workload Allotted in hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit-I **Food Spoilage**	1. Introduction of food spoilage and its type. 2. Causes of food Spoilage: Bacteria, Protozoa and Fungi. 3. Factors affecting the spoilage of food such as temperature, pH, types of food and its contents. 4. Symptoms & Consequence of food spoilage. 5. Methods for detection of food spoilage	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or
Unit-II **Food Hygiene and Food born diseases**	1. Concept of food hygiene 2. Principles of Hygiene and Sanitation in Food Service unit. 3. Measures for food hygiene and safe food	7 hrs	7 marks	

	handling procedures. 4. Causes, symptoms, prevention and control of following food borne diseases i.*Staphylococcus* food poisoning ii. *Clostridium botulism* food poisoning iii. *Campylobacter jejuni* iv. *Salmonella* food poisoning			video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore Topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit-III **Food Preservation**	1. Concept of food preservation. 2. Principle and Need of Food Preservation 3. Methods for preservation- Freezing, Boiling, Salting, Sweetening, Dehydration. 4. Modern industrial methods for preservation- Vacuum-packing / Canning, Pasteurization, Artificial food additives/Chemical preservatives, Irradiation of food	7 hrs	7 marks	
Unit-IV **Food safety**	1. Food Safety Laws 2. Food adulteration. 3. Measures for Food Safety and Quality Management System 4. Shelf life and expiry of food products.	8 hrs	8 marks	

References

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition. New Age International (P) Limited Publishers, New Delhi, India.

2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.

3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.

4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.

5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.

7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1- 2, ASPEN Publication, Gaithersberg, MD.

9. Matthews KR,Kniel KE, and Montville TJ. (2017). Food Microbiology: An introduction. 4th edition, ASM Press.

Model Questions :

1.Explain the factors affecting the spoilage of food

2. Explain the symptoms & consequence of food spoilage

3. How you detection of food spoilage

4. Why hygiene and sanitation in food service unit is important

5. What are causes and symptoms of food borne diseases

6. How you prevention food borne diseases

7. Explain the need of food preservation

8. Explain the methods for preservation

9. Explain food Safety Laws

10. Describe the food adulteration

11. Explain the shelf life and expiry of food products

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 base on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 test</td><td rowspan="3">10 Marks</td></tr>
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<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years- Six Semesters Bachelor's Degree Programme)

FIRST YEAR: SEMESTER – II

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major /Minor Microbiology 127	Theory- 2	127205	Bacteriology and Microbial control
		Lab/ Practical-3	127206	Techniques for culturing Bacteria
b.	Major/ Minor	Theory- 2	-	-
		Lab/ Practical-2	-	-
c.	Generic/ Open Elective 127	Theory- 3	127207	Microbes for Sustainable Agriculture
		Theory- 4	127208	Composting and Biogas Technology
d.	VSC	Lab/ Practical-4	127209	Microbial Control
	SEC	Lab/ Practical- 5	127210	Isolation and Morphological Characterization of Bacteria
e.	AEC - English	Theory		
	AEC –MIL	Theory		
	VEC	Theory		
f.	CC	Outdoor		

127205 Theory 2 : Bacteriology and Microbial Control							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
4.5	II	127205	Bacteriology and Microbial control	2	30	2 Hrs	30(Ext) + 20(Int)

Course Objectives

- To impart knowledge about structural features and components of bacterial cell.
- To impart knowledge about various methods of controlling the growth of microorganisms.
- To educate the students about nutritional aspects of microbial cultivation.
- To explain classification scheme of bacteria and characteristics of different taxonomic groups of bacteria.

Course Outcomes

Upon completion of this course successfully, students would be able to

- Describe structural features and components of bacterial cell.
- Apply the knowledge of microbial nutrition for culturing microorganisms in laboratory
- Select the method of microbial control depending on the objective while working.
- Illustrate classification of bacteria and characteristics of different taxonomic groups of bacteria.

Unit System	Contents	Workload Allotted in hours	Weightage of Marks Allotted	Pedagogy
Unit I **Structural Organization of bacteria**	➢ Typical Bacterial cell: Shape, Size, and Arrangement of Bacteria ➢ Structure and functions of following • Capsule and slime layer • Cell wall- Gram positive and Gram negative bacteria • Cytoplasmic membrane- fluid mosaic model • Flagella-Arrangement, Mechanism of flagellar movement • Pili- Arrangement and function • Ribosomes- Prokaryotic and Eukaryotic ➢ Plasmid- Definition, General characters, classes ➢ Bacterial chromosome ➢ Endospores- Structure and arrangements	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models:** use of model, Charts. **Problem-Solving Sessions:** Organize regular problem-solving sessions.

Unit II **Microbial Nutrition**	**Microbial Nutrition:** ➢ Basic Nutritional Requirements: Sources of C, N, O, P, S, Energy, Macronutrients, Growth factors, water etc. ➢ Media, Synthetic, Non synthetic, liquid and Solid, Semisolid, Differential, Enriched, Selective media. Role ➢ Of beef extract, yeast extract, peptone, agar in nutrient media. ➢ Determination of nutritional requirements: Auxanographic technique, Replica plating technique. ➢ Nutritional classification on the basis of source of carbon and ➢ energy	7 Hrs	7 Marks	**Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable
Unit III **Microbial control**	➢ Definition and Terms ➢ Sterilization, disinfection, Antiseptic, Sanitizer, Germicide, Microbiostatis, Antimicrobial agent. ➢ Physical Control ➢ Temperature, osmotic pressure, Radiation, filtration. ➢ Chemical Control ➢ Chemistry and mode of action of halogens, heavy metals and their derivatives, Alcohols, Detergents and Gaseous Sterilization	8 Hrs	8 Marks	
Unit IV **Bacterial Systematics**	➢ Taxonomy, Classification, Identification, Nomenclature ➢ Identification criteria: Morphological, biochemical, cultural, serological ➢ Methods of classification: numerical taxonomy, r-DNA ➢ sequencing, phylogenetic tree ➢ Outline of Bergey's manual of systematic Bacteriology ➢ (2^{nd} Edition) (Vol. I to V – 2001-2012) ➢ Introduction of Online Bergey's manual of systematic of Archea & Bacteria (1^{st} Edition 2015)	7 Hrs	7 Marks	

References	➢ Microbiology: Pelczar, Chan, Krieg.(TMH) Text Book of Microbiology: Dubey & Maheshwari (S. Chand, Publication) ➢ Fundamental of Microbiology: Frobisher ➢ General Microbiology Vol. I & II: Pawar & Daginawala (Himalaya Publication) ➢ Fundamentals of Principles: A.J. Salle. bacteriology ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II
Model Questions	**Short Answer Questions** 1. Draw well labeled diagram of typical bacterial cell 2. Characterize the bacteria on the basis of shape size and arrangement 3. Discuss the structure of capsule with their function 4. Differentiate between Gram positive and Gram negative cell wall of bacteria 5. With the help of diagram discuss fluid mosaic model 6. Illustrate the mechanism of flagellar movement 7. Give the characteristics of plasmid 8. What are basic nutrients required for the growth of bacteria 9. Differentiate between synthetic and non-synthetic media 10. Differentiate between solid and liquid media 11. Discuss various selective media 12. Explain the role of peptone and beef extract 13. Give detail account on Auxanographic technique 14. Give detail account on Replica plating technique 15. Explain different types of media 16. Define Sterilization , disinfectant 17. Define antiseptic and Germicide 18. Define micro biostatic and antimicrobial agent 19. Explain radiation used to control microorganism 20. How will you control microbial population by using osmotic pressure 21. Write the mode of action of heavy metals 22. Explain any two methods of chemical control 23. Write any two terminologies to control microbial growth 24 Give the outline of Outline of Bergey's manual of systematic bacteriology

24. Explain low G+C Gram positive bacteria
25. Explain high G+C Gram positive bacteria
26. Define and explain numerical taxonomy and r-DNA technology
27. Define the terms: Taxonomy and classification

Long Answer Questions

1. Give the outline nutritional classification on the basis of carbon source
2. Give the outline nutritional classification on the basis of energy source
3. Discuss in detail control of microorganisms by physical control
4. Discuss in detail control of microorganisms by chemical control
5. Explain the cell wall of Gram positive and Gram negative bacterial cell
6. Explain any two prokaryotes from domain bacteria
7. Explain in detail identification criteria

Multiple choice Questions

1. Which of the following is a function of cry protective agent

a. For long term preservation of culture
b. Prevents cell damage due to ice crystal formation
c. Prevents formation of ice
d. To trap the liquid nitrogen

2. What is the temperature of liquid nitrogen

a) -120^0C c) -150^0C
b) 0^0C d) -196^0C

3. Yeast extract is an excellent source of

a) Vitamin c) Carbohydrates
b) Protein d) Vit. A

4. In the synthesis of cell components, the major element required is

a) Sulfur c) Nitrogen
b) Carbon d) Oxygen

5. The effectiveness of chemical disinfectant has historically been compared with

a) Phenol c) blench
b) Ethyl alcohol d) Formaldehyde

6. The bacterial Pili mainly contain

a. Carbohydrates b. Lipids

	c. **Proteins** d. Minerals 7. Which of the following gene deduced the evolutionary relationship between the taxonomic groups? a. **16s RNA** b. 23s RNA c. 5s RNA d. 18s RNA 8. Name the scientist who proposed the phylogenetic tree for living things a. Carlo Urbani b. Louis Pasteur c. Robert Koch d. **Carl Woese**

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		**20 Marks**

127206 Lab 3 : Techniques for Culturing Bacteria							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	127206	Techniques for culturing Bacteria	2	60	2 Hrs	25(Ext) + 25 (Int)

Course Objectives

- To study the handling of different laboratory instruments
- To know the proper method for preparation of laboratory media for cultivation of organisms
- To study the effect of different environmental factors which affect the growth of microorganisms
- To practice the storage techniques of pure cultures of an organisms

Course Outcomes

Upon completion of this course successfully, students would be able to

- Acquire the skill in the use and care of basic Microbiological equipment.
- Get employment in diagnostic laboratories.
- Analyze the effect of different parameters on growth of bacteria.
- Determine the nutritional requirement of microorganisms

Sr. No.	**Contents of Practical (**List of Laboratory Experiments/ Activities etc.)
1.	Isolation of bacteria from soil suspension using inoculating needle
2.	Isolation of bacteria from rotting vegetables by Pour plate method
3.	Isolation of bacteria from water sample by Spread plate method
4.	Isolation of bacteria from food sample by Streak plate method and study its colony characteristics
5.	Isolation of bacteria from human body surface/ mobile phones using cotton swabs
6.	Cultivation of bacteria on slants and study the morphological characteristics by simple staining
7.	Cultivation of Bacteria using nutrient broth
8.	Determination of nutritional requirement of bacteria by replica plate technique
9.	Study of permanent/ freshly prepared slides of Spirochetes, Mycobacterium, Actinomycetes, bacterial flagella, lactobacillus
10.	Isolation of bacteria using selective media

References:	➢ Microbes in Action: Seely, Wander Mark Tarporewala, Bombay ➢ A Mannual of Microbiology: A.J. Salle. Methods ➢ Medical Microbiology Vol. II: R. Cruickshank ➢ Microbiology Methods: Collins Difco mannual ➢ Bacteriological Techniques: F.J.Baker ➢ Introduction to Microbial: Gunasekaran Techniques ➢ Biochemical methods: Sadashivam & Manickam ➢ Laboratory of Fundamentals: Alcamo, I.E., Jones and Microbiology Bartlett Publishers ➢ A textbook of Practical Microbiology (B Sc Sem 1 & 2): Dr. R. R. Pachori, P.S.Sadar, Dr. A. M. Pande, 2nd Edition

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	Total	25 Marks

127209 VSC Lab Practical 4 : Microbial Control							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	127209	Microbial control	2	60 Hrs	2 Hrs	50 (Int)

Course Objectives

- To train the students in methods of sterilization using high temperature.
- To impart training of using and studying the effect of different methods of chemical control.
- To educate the students about applying filtration technique, gaseous sterilization and application of UV rays for microbial control.

Course Outcomes

Upon completion of this course successfully, students would be able to

- Use techniques of sterilization using autoclave and oven.
- Apply the knowledge of chemical control in laboratory as well as day to day life.
- Use filtration technique and gaseous sterilization method in appropriate way.
- Make use of laminar air flow cabinet for microbiological experiments.

Sr. No.	Contents of Practical (List of Laboratory Experiments/ Activities etc.)
1.	Sterilization of nutrient medium with autoclave
2.	Sterilization of glass ware using hot air oven
3.	Sterilization of solution using filtration
4.	Control of growth using salts-Effect of osmotic pressure on growth of bacteria
5.	Effect of low temperature on growth of bacteria
6.	Effect of heavy metals on growth of bacteria
7.	Effect of antibiotics on growth of bacteria
8.	Effect of soap on growth of bacteria by studying the effectiveness of hand washing
9.	Effect of antifungal agents on growth of fungi
10.	Gaseous sterilization
11.	OT sterilization

References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by-S.Chand ➢ A Text book of Practical microbiology by P.S. Sadar and A.M. Pande, Ed. Rachana Pachori (Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I & II: Power & Daginawala. (Himalaya Publication) ➢ Fundamentals of Principles: A.J. Salle. bacteriology ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by- S. Chand ➢ Textbook of Microbiology(Fourth edition): Prof. C P Baveja Published by Arya publications

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

127210 SEC -Lab Practical 5: Isolation and morphological characterization of bacteria							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	127210	Isolation and morphological characterization of bacteria	2	60	2 Hrs	50 (Int)

Course Objectives	➢ To train the students in methods of isolation of bacteria from different sources. ➢ To impart training of morphological characterization of bacterial colonies. ➢ To educate the students about choosing proper media for cultivation, and ➢ Staining techniques for morphological characterization of bacteria.
Course Outcomes	Upon completion of this course successfully, students would be able to ➢ Use techniques of isolation of bacteria from different sources. ➢ Apply the knowledge for morphological characterization of bacterial colonies ➢ Make use of different types of media for cultivation of various types of bacteria. ➢ Characterize different bacteria with respect to their shape, arrangement and gram character.
Sr. No.	**Content of Practical (**List of Laboratory Experiments/ Activities etc.)
1.	Isolation and characterization of bacteria from soil
2.	Isolation and characterization of bacteria using enrichment culture
3.	Isolation and characterization of bacteria using selective media
4.	Isolation and characterization of bacteria from mixed culture using differential media
5.	Isolation and characterization of lactobacilli from curd
6.	Isolation and characterization of bacteria from skin
7.	Isolation and characterization of bacteria from teeth
8.	Isolation and characterization of bacteria from air
9.	Isolation of bacteria from sewage

References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ A Text book of Practical microbiology by Sadar and Pande, Ed. Rachana

	Pachori (Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I & II: Power & Daginawala (Himalaya Publication) ➢ Fundamentals of Principles: A.J. Salle. bacteriology ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

Internal Evaluation for SEC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

127207 Theory 3 (Generic Open Elective Course) Microbes for Sustainable Agriculture							
Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	II	127207	Microbes for Sustainable Agriculture	2	30	2Hrs	30 (Ext) + 20(Int)

Course Objectives:	To understand the role of different microorganisms in disease formation To apply this knowledge to control infectious diseases.
Course Outcomes	Upon completion of this course successfully, students would be able to 1. Acquire knowledge about vectors that transmit diseases 2. Know how the diseases spread in the community 3. Understand occurrence of symptoms in diseases 4. Know the methods of prevention of spread of diseases in community 5. Control of disease agent and hence diseases

Unit System	**Contents**	**Workload Allotted in hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit 1 Concepts of Soil Microbiology	Soil physico-chemical properties Soil organic matter and humus Soil microbial communities Concept of Rhizosphere Rhizospheric microbes and their significance Role of soil microbes in composting and humus formation	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:**
Unit 2 Plant Microbe interactions	Positive interactions Negative interactions Plant growth promoting bacteria	7 hrs	7 marks	

	(PGPR) Concept of rhizobium-legume symbiosis Concept of Mycorrhizal symbiosis			Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore Topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 Biofertilizers	Basic concept of Biofertlizers Nitrogen fixers: Symbiotic and non-symbiotic Use of microorganisms as Biofertilizers Types of Biofertilizers Advantages of Biofertilizers	8 Hrs	8 Marks	
Unit 4 Biocontrol agents	Adverse effects of chemical pesticides,fungicides and nematocides Use of microorganisms as biocontrol agents Biopesticides Biofungicides Bioinsecticides Bionematocides Entamopathogenic fungi	7 hrs	7 marks	

References:

- Agricultural Microbiology by G. Rangaswami and D. Bagyaraj
- Introduction to Soil Microbiology by Alexander M. Wiley Eastern ltd.
- Biofertilizers in Agriculture and Forestry by Subbarao N.S, Oxford and IBH

- Principles of Microbiology, Atlas RM, Wm.C. Brown Pub, USA
- Plant pathology by Mehrotra R and Agarwal A, Tata Mcgraw- Hill pub.
- A textbook of Microbiology by R.C. Dubey and D. K. Maheshwari, Chand and company.

Model Questions	**Long questions:** 1. Explain the concept of Rhizospheric microbes and their significance 2. Explain the Concept of rhizobium- legume symbiosis 3. Explain the use of microorganisms as Biofertilizers. 4. Explain the use of microorganisms as Bio-control agent. **Short questions:** 1. What is Humus? 2. What is compost? 3. What is PGPR? 4. Define symbiosis. 5. Differentiate between symbiotic and non- symbiotic nitrogen fixing microorganisms 6. What are the advantages of biofertilizers? 7. Define biopesticides. 8. Define insecticides. **MCQ'S** 1. Which of the following is symbiotic nitrogen fixing microorganism? a. Azotobacter b. E. coli c. Rhizobium d. S.aureus 2. The full form of PGPR is------- a. Plant growth promoting rhizobacteria b. plant growth preventing rhizobacteria c. plant growth producing rhizoctonia d. plant growth promoting rhizoctonia 3. The area surrounding the plant root is called as----- a. Phyllosphere b. Rhizosphere c. Hemisphere d. Ecosphere 4. Bacillus thuringiensis is used as----- a. Biofertilizer b. Bionematocide c. Biopesticide d. Bioinsecticide

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 base on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 test</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 base on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

127208 Theory 4 Theory 1 (Generic Open Elective Course) Composting & Biogas Technology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	127208	Composting & Biogas Technology	2	30	2Hrs	30 (Ext) + 20 (Int)

Course Objectives:	To understand the role of different microorganisms in disease formation To apply this knowledge to control infectious diseases.
Course Outcomes	Upon completion of this course successfully, students would be able to 1. Acquire knowledge about vectors that transmit diseases 2. Know how the diseases spread in the community 3. Understand occurrence of symptoms in diseases 4. Know the methods of prevention of spread of diseases in community 5. Control of disease agent and hence diseases

Unit System	**Contents**	**Workload Allotted in hours**	**Weightage of Marks Allotted**	**Pedagogy**
UNIT I Introduction of Composting	Definition of compost Classification of composting Science of composting Role of microbes in composting Importance of composting	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between
Unit II Kinetics and Biochemistry of Composting	Carbon-nitrogen Balance; Ideal C: N Ration; Moisture content Temperature and oxygen availability	7 hrs	7 marks	
Unit III Methods for Composting of Wastes	Indore Method Activated Compost Bangalore Method NADEP Method Windows Composting	8 Hrs	8 Marks	
Unit IV	Introduction to Biogas	7 hrs	7 marks	

Biogas Technology	Role of Microbes in Biogas Scope of Biogas in India Design and Construction of Biogas Advance technology for Biogas energy production			different concepts. **Inquiry-Based Learning:** Explore Topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**

References

1. Composting Technology by D K Gupta Laxmi Lal
2. The Rodale Book of Composting, Newly Revised and Updated: Simple Methods to Improve Your Soil, Recycle Waste, Grow Healthier Plants, and Create an Earth-Friendly Garden (Rodale Classics)
3. The Complete Technology Book on Biofertilizer and Organic Farming Paperback – 31 December 2022 by Dr. Himadri Panda (Author)
4. The Organic Waste Composting Handbookby Jackson Lawrence

Model Questions	1. Explain Composting and its classification. 2. What is the role of Microbes in Composting? List few commonly used Microbes. 3. How do microorganisms contribute to the breakdown of organic materials 4. Why is composting considered necessary in sustainable waste management and agriculture practices? 5. What does the C:N ratio describe, and why is the optimal C:N ratio essential? 6. What factors, such as moisture content, temperature, and oxygen availability, influence the success of the composting process? 7. Differentiate between the Indore, Activated, Bangalore, and NADEP composting methods. What are their respective advantages and limitations? 8. What is the significance of windows composting, and how does it

	differ from traditional composting methods? 9. Introduce the concept of biogas, elucidating the role of microbes in biogas production. 10. Describe how biogas can benefit India and discuss technological advancements for efficient biogas energy production.

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		**20 Marks**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: MICROBIOLOGY

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027)

Under Uniform NEP 2020

SYLLABUS

Semester - III and IV

Teaching and Learning Scheme: for the Degree of Bachelor of Science (Three Years- Six Semesters Bachelor's Degree Programme) SECOND YEAR: SEMESTER – III

Programme :B. Sc. (Microbiology)

Course : B. Sc. II - Semester III

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major Microbiology 127	Theory- 3	127211	Bacterial Growth and Pure Culture
		Theory- 4	127212	Fundamentals of Virology
		Lab/ Practical- 6	127213	Techniques for Bacterial Growth and Pure Culture
	IKS Major Specific	Theory	127214	IKS in Microbiology
b.	Minor 127	Theory- 3	127215	Microbial Reproduction and Bacterial Pure Culture
		Lab/ Practical-3	127216	Techniques of Microbial culture, Bacterial Physiology and Pure Culture
c.	Generic/ Open Elective 127	Theory- 5	127217	Applied Microbiology for Day to Day Life
d.	VSC	Lab/ Practical-7	127218	Microbial cultivation and Culture Preservation
e.	AEC - English	Theory		
	AEC –MIL	Theory		
f.	FP/CES	Project	127219	FP/CES in Microbiology-I
	CC	Outdoor		

Programme: B.Sc. (Microbiology)

Course: **B. Sc. II Semester III**

127211 Theory 3 (Major) :Bacterial Growth and Pure Culture							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127211	Bacterial Growth and Pure Culture	2	30	2Hrs	30 (Ext) + 20 (Int)

Course Objectives

- To impart knowledge about growth and reproduction of bacteria.
- To make the students understand the bacterial growth curve.
- To impart knowledge about various methods of measurement of growth of microorganisms.
- To make the student understand different methods of pure culture isolation, maintenance and preservation.

Course Outcomes

Upon completion of this course successfully, students would be able to

- Illustrate bacterial growth curve and methods of reproduction of bacteria.
- Apply the knowledge for isolation of pure culture.
- Select appropriate method for growth measurement of microbial culture.
- Select the method of pure culture maintenance and preservation depending on the objective while working.

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 Reproduction and growth	➢ Definition of growth, Difference in growth of unicellular and multicellular organisms ➢ Reproduction: Binary fission, Budding, Fragmentation, sporulation ➢ Growth rate and generation time, Mathematical expression of growth.	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts.

	➢ Bacterial growth curve ➢ Factors influencing bacterial growth: Temperature, pH Gaseous requirements, osmotic pressure and microbial groups on the basis of these factors.			**Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore Topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 2 Measurement of Growth:	➢ Cell number measurement: Breed method, counting ➢ chamber method, Electronic counters and Colony count ➢ Membrane filter count ➢ Determination of cell density by Turbidity measurement ➢ Cell mass measurement - ➢ Dry weight	7 Hrs	7 marks	
Unit 3 Pure Culture Techniques	➢ Definition-Pure and Mixed culture ➢ Methods of isolation of Pure culture: Streak plate, Pour plate and Enrichment culture ➢ Special isolation methods, ➢ Single cell isolation technique ➢ Systematic Study of pure cultures	8 Hrs	8 marks	
Unit 4 Culture Preservation	➢ Maintenance of stock cultures ➢ Methods of preservation of pure culture: Agar slants, Saline suspension, Overlaying with oil ➢ Special methods: glycerol stock with glass beads, liquid nitrogen Freeze drying/Lyophilization.	7 Hrs	7 marks	

	➢ Introduction of Microbial cultural collection centre ATCC, ITCC, MTCC and NCIM			

References	➢ Microbiology : Pelczar, Chan, Krieg.(TMH) ➢ Text Book of Microbiology : Dubey & Maheshwari (S. Chand, Publication) ➢ Fundamental of Microbiology : Frobisher ➢ General Microbiology Vol. I &II: Power & Daginawala. (Himalaya Publication) ➢ Fundamental Principles of bacteriology :Salle, A. J. ➢ Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II ➢ Microbiology an introduction (Ninth edition)By-Tortora, Funke, Case Published by-Dorling Kindersley (India) Pvt Ltd. ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ Textbook of Microbiology (Fourth edition) Prof. C P Baveja Published by Arya publications.
Model Questions	**Short Answer Questions** 1. Define reproduction and explain different types of reproduction 2. How will you calculate generation time with the help of mathematical expression 3. Explain Cummings Technique for synchronous culture 4. How will you measure cell number by Breed method 5. How will you measure cell mass by turbidity measurement 6. Discuss the effect of temperature on the growth of bacteria 7. Discuss the effect of pH on the growth of bacteria

8. Discuss the effect of gaseous requirements on the growth of bacteria
9. Define pure culture and mixed culture
10. Explain streak plate method for isolation of pure culture
11. Explain pour plate method for isolation of pure culture
12. Explain enrichment culture technique for isolation of pure culture
13. Write the long form of ATCC, ITCC, MTCCAND NCIM
14. Explain any two methods of preservation of pure culture

Long Answer Questions

1. Discuss steps involved in growth curve
2. Explain in detail any two factors influencing bacterial growth
3. Explain any two methods for isolation of pure culture
4. Explain in detail methods of preservation of pure culture

Multiple choice questions

1. Pure culture is a growth of a single organism belonging to the same

a) Family c) Species

b) Genus d) order

2. The number of viable cell count is determined by

a) Breed method c) Cell mass measurement

b) Turbidity measurement d) Standard plate count

3. Shortest generation time is found in

a) Maximum stationary phase c) Logarithmic death phase

b) Logarithmic growth phase d) Survival phase

4. The principle involved in the streak plate method is

a) Separation b) Isolation

b) Streaking c) Dilution

5. In pour plate method, the medium should be maintained at temperature

a) 37^0 C b) 45^0C

b) 67^0C d) 0^0C

6. Which of the following is a function of cryoprotective agent

a) For long term preservation of culture

b) Prevents cell damage due to ice crystal formation

c) Prevents formation of ice

	d) To trap the liquid nitrogen 7. What is the temperature of liquid nitrogen a) -120^0C c) -150^0C b) 0^0C d) -196^0C

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.(any two activity 5 mark each)		10 Marks
Total		20 Marks

127212 Theory 4 (Major) : Fundamentals of Virology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127212	Fundamentals of Virology	2	30	2Hrs	30 (Ext) + 20 (Int)

Course Objectives

- To impart knowledge about general characteristics and types of Viruses.
- To make the students understand the viral multiplication.
- To impart knowledge about various methods of viral cultivation
- To make the student understand different applications of viruses and harmful activities of viruses.

Course Outcomes

Upon completion of this course successfully, students would be able to

- Illustrate structure of viruses and methods of their replication.
- Explain various methods for cultivation of viruses.
- Describe the applications of viruses for beneficial purpose.
- Use the knowledge about viral diseases for healthy life.

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 General characteristics of viruses	➢ General characteristics of viruses, ➢ Types of viruses depending on hosts ➢ Structure of viruses- Icosahedral, helical & binal symmetry. Classification of viruses.(LHT Classification)	7 Hrs	7 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs

Unit 2 Viral Multiplication	➢ Replication of bacteriophages: One step growth experiment, Lytic cycle in T4 bacteriophage, Lysogenic cycle in lambda phage ➢ Reproduction of plant virus- Tobacco Mosaic Virus ➢ Reproduction of animal Virus -Adeno virus	8Hrs	8 Marks	and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 Cultivation of Viruses and Interferon	➢ Cultivation of Animal viruses: Tissue culture, chick embryo and live animals ➢ Cultivation of Plant viruses: whole plant, protoplast ➢ Cultivation of Bacteriophages - Plaque method ➢ Detection of viral growth ➢ Interferons	8 Hrs	8 Marks	
Unit 4 Viruses for Human Welfare and Viral Diseases	➢ Viral pesticides ➢ Introduction of Viral vectors for genetic engineering, virus as vectors for gene therapy ➢ viral vaccines ➢ Pathogenic viruses – Structure, symptoms Transmission and prevention (Hepatitis, Corona Virus and Dengue)	7 Hrs	7 Marks	
References	➢ Microbiology : Pelczar, Chan, Krieg.(TMH) ➢ Text Book of Microbiology : Dubey & Maheshwari (S. Chand, Publication) ➢ Fundamentals of Microbiology : Frobisher ➢ General Microbiology Vol. I &II : Power & Daginawala. (Himalaya Publication)			

	➢ Fundamental Principles of bacteriology: Salle, A.J. ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ Microbiology an Introduction (Ninth edition)By-Tortora, Funke, Case Published by-Dorling Kindersley (India) Pvt Ltd. ➢ Practical Microbiology (Revised edition R.C.Dubey and D. K. Maheshwari Published by-S. Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications ➢ Virology - Biswas and Biswas ➢ Virology Vol. 4- Toply and Wilson ➢ Principals of virology- S.J. Flint ➢ Bacterial and Phage Genetics – Birge
Model Questions	**Short Answer Questions** 1. Illustrate general characteristics of Viruses 2. Give the outline classification of Viruses 3. Explain any one structure of Viruses 4. What is replication? Explain Lytic cycle in detail 5. Explain in detail lysogenic cycle by Lambda phage 6. How will you cultivate bacteriophage in laboratory 7. Explain in detail embryonated egg 8. How will you detect viral growth? 9. Explain viral assays 10. How will you prepare viral pesticides and its applications 11. Explain the use of viral vectors in genetic engineering 12. Give the outline of human pathogenic viruses 13. Give the outline of plant pathogenic viruses 14. Explain one step growth experiment. 15. Explain viral vaccines **Long Answer Questions** 1. Explain different types of structure of Viruses 2. Discuss in detail multiplication of animal viruses

	3. Explain any two methods of cultivation of animal viruses 4. Explain any two types of viral diseases **Multiple choice questions** 1. Which of the following is the genome of the viruses a) DNA c) DNA or RNA b) RNA d) DNA and RNA 2. Which of the following statements are true about the viruses a) Ultramicroscopic c) Both a and b b) Obligate parasite d) None of the above 3. Lysogenic is replication of a) Viruses c) Actinomycetes b) Bacteria d) Fungi 4. Lytic cycle is replication of a) Viruses c) Actinomycetes b) Bacteria d) Fungi 5. which plaque is an example of temprate phage a) Lambda c) Cellular b) T4 d) Eukaryotic 6. Which phage is an example of virulent phage a) Lambda c) Cellular b) T4 d) Eukaryotic 7. Tobacco mosaic virus is--------agent a) Filterable c) Cellular b) Non filterable d) Eukaryotic 8. Viruses are resistant to a) Antibiotics c) Antipyretic agent b) Antiviral agent d) all of these

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 base on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 test</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 base on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.(any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

127213 Lab Practical 6 (Major) : Techniques for Bacterial Growth and Pure Culture							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127213	Techniques for Bacterial Growth and Pure Culture	2	60	2Hrs	25 (Ext) + 25 (Int)

Course Objectives	➢ To train the students in methods of microbial cultivation. ➢ To impart training of using and studying the effect of different environmental conditions on growth of bacteria. ➢ To educate the students about applying growth measurements techniques.
Course outcomes	Upon completion of this course successfully, students would be able to ➢ Use techniques of microbial cultivation. ➢ Apply the knowledge of effect of different environmental conditions on growth of bacteria for determination of physical conditions required for growth. ➢ Select and use appropriate growth measurement techniques depending on the need.

Sr. No.	**Content of Practical (List of Laboratory Experiments)**	**Incorporation of Pedagogies**
1	Determination of Optimum temperature for growth of bacteria	**Experiential Learning:** Hands-on experimentations. **Inquiry-Based Learning**: **Collaborative Learning:** Group-based activities, Post-experiment discussions encourage critical evaluation. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.
2	Determination of optimum pH for growth of bacterial culture.	
3	Isolation of pure culture of bacteria using streak plate method	
4	Isolation of pure culture of bacteria using pour plate method	
5	Effects of salts/ sugar concentration on bacterial growth.	
6	Pour plate technique for viable count.	
7	Candle jar method for cultivation of anaerobic bacteria	
8	GasPak Anaerobic jar method for cultivation of anaerobic bacteria	
9	Determination of cell density by Turbidity measurement	
10	To study the bacterial growth curve	

References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by S.Chand ➢ A Text book of Practical microbiology by Sadar and pande,Ed.RachanaPachori(Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I &II : Power &Daginawala. (Himalaya Publication) ➢ Fundamental Principles of bacteriology : Salle, A. J. ➢ Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II ➢ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

127214 Theory IKS Major Specific : IKS in Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127214	IKS in Microbiology	2	30	2Hrs	30 (Ext) + 20 (Int)

Course Objectives

- To impart knowledge about Indian contribution to Microbiology.
- To make the students aware about concept of Microbes in Ayurveda and Agriculture.
- To impart knowledge about Traditional fermentation and food preservation techniques.
- To make the student aware about Traditional Indian practices involving Microbiology

Course Outcomes

Upon completion of this course successfully, students would be able to

- Illustrate the contribution of Indians sages and Scientists in Microbiology
- Explain the concept of Microbes in Ayurveda and agriculture.
- Describe various traditional fermented foods and preservation techniques.
- Integrate traditional Microbiological knowledge with modern Science

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 Microbiology in ancient Indian Knowledge system	➢ Introduction of IKS in relation to Microbiology ➢ Microbiological concept in ancient Indian Knowledge resources: • Rigveda • Atharvaveda • Charak Samhita • Sushruta Samhita • Padmapuran ➢ Contributor of Indian Knowledge system with reference to Microbiology: • Rishi Kanva • Rishi Agastya ➢ Charaka and Sushruta	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or

Unit 2 **Concept of Microbiology in Ayurveda and Agriculture**	➢ Herbs and natural remedies ➢ Traditional remedies for microbial infections: Turmeric, Neem, Tulsi, Aloe vera ➢ Indigenous probiotics and gut health ➢ Traditional farming practices: crop rotation, Mixed cropping, organic farming, compost as fertilizers, panchgavya	7 Hrs	7 Marks	video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze & discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 **Traditional Fermentation and Food Preservation**	➢ Role of microbes in traditional Indian foods: Yogurt(curd), Idli and dosa, pickles and sauces, coconut Toddy, Gundruk ➢ Traditional preservation techniques: sun drying, pickling, oil and spice preservation, sugar preservation, smoking and drying, salt preservation ➢ Traditional packaging: banana leaves, containers, coatings	8 Hrs	8 Marks	
Unit 4 **Traditional Indian practices involving Microbiology**	➢ Rituals and practices involving microbes: Yogic practices, cow dung, cow urine, Ganga water, Panchamrita, Ashes and Bhasma, cremation practices, Agnihotra and its significance ➢ Traditional water purification and storage practices ➢ Microbial pigment in Indian traditional art ➢ Modern discoveries based on Traditional Indian knowledge of Microbiology	7 Hrs	7 Marks	

References	➢ Vedic Microbiology: A scientific approach. Author Dr. R. C. Dubey pub. Motilal Banarsidass international Delhi. ➢ Microbial mysteries of India: Indai's rich legacy in Microbiology author Sanjo S. Thomas Pub. Kitab writing publication ➢ Sukshmjeevanu in Vedas: The Forgotten Past of Microbiology in Indian Vedic Knowledge 2021. Urvashi Kuhad, Gunjan Goel, Pawan K. Maurya, Ramesh C. Kuhad. Indian journal of Microbiology, 61(1): 108-110. ➢ Vedic Microbiology Revisited: Insights, Contributions, and Relevance. Akanksha and Shivam Kumar Rai, Agri articles, Volume: 04, Issue: 03 (May-June, 2024) ➢ A glimpse of Ayurveda :The forgotten history and principles of Indian traditional medicine, Yogini S. Jaiswal, Leonard L. Williams. Journal of Traditional and Complementary Medicine 7 (2017) 50- 53
Model Questions	**Short Answer Questions** 1. Explain the microbiological concepts given in Rigveda. 2. Discuss Athar vaveda with respect to Microbiology. 3. Discuss Charak Samhita with reference to Microbiology. 4. Explain Sushruta Samhita with reference to surgery and medical innovations. 5. Discuss the concept of microorganisms in Padmapuran. 6. Explain the contribution of Rishi Kanva in the field of Microbiology. 7. Explain the contribution of Rishi Agastya in the field of Microbiology. 8. Explain the contribution of Carak and Sushruta in the field of Microbiology. 9. Discuss Indigenous probiotics and gut health. 10. Explain the role of turmeric against microbial infections. 11. Describe Panchgavya in farming. 12. Describe Role of microbes in pickles and sauces. 13. Explain salt preservation technique.

14. Explain Agnihotra and its significance.

Long Answer Questions

1. Explain the Microbiological concept in ancient Indian Knowledge resources.
2. Discuss the Contributors of Indian Knowledge system with reference to Microbiology.
3. Describe Traditional remedies for microbial infections.
4. Explain Traditional farming practices.
5. Explain Traditional preservation techniques.
6. Describe Modern discoveries originated from Traditional Indian knowledge of Microbiology.

Multiple choice questions

1.----------is called as Father of Microbiology as per vedas.

a)Rishi Agastya b) Rishi Kanva c) Charaka d) Sushruta

2.Panchamrita consists of _____ingredients.

a)4 b) 1 c) 5 d) 2

3. ----------is known as the "Father of Surgery" and is considered a pioneer in ancient Indian medicine.

a) Sushruta b) Charak c)Rishi Agastya d)Rishi Kanva

3.----------is use for healing wounds.

a)Aloe vera b) Tulsi c) Turmeric d) Neem

4.Vermicompost is prepared from_____.

a)snail b) earthworm c) Plants d) Animals

6.Salt is used as----------

a)Additive b) preservative c) colorant d) sweetner

7.Gundruk is prepared from-------

a)Cabbage b) Turnip c) Beetroot d) Leafy vegetables

8.----------is a Vedic ritual that involves offering substances to a sacred fire.

a)Agnihotra b) homa c) Both a and b d) None of these

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<tr><td>MCQ Test 2 base on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.
(any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

127215 Theory 3 (Minor) : Microbial Reproduction and Bacterial Pure Culture							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127215	Microbial Reproduction and Bacterial Pure Culture	2	30	2Hrs	30 (Ext) + 20 (Ext)

Course Objectives

- To impart knowledge about growth and reproduction of bacteria.
- To make the students understand the bacterial growth curve.
- To impart knowledge about various methods of measurement of growth of microorganisms.
- To make the student understand different methods pure culture isolation, maintenance and preservation.

Course Outcomes

Upon completion of this course successfully, students would be able to

- Illustrate bacterial growth curve and methods of reproduction of bacteria.
- Apply the knowledge for isolation of pure culture.
- Select appropriate method for growth measurement of microbial culture.
- Select the method of pure culture maintenance and preservation depending on the objective while working.

Unit System	**Contents**	**Workload allotted**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit 1 Microbial Reproduction	➢ Bacterial Reproduction: Binary fission, Budding, Fragmentation, ➢ Fungal Reproduction-Sexual and Asexual ➢ Viral multiplication-Lytic & Lysogeny cycle	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts.

Unit 2 Bacterial growth	➢ Definition of growth Difference in growth of unicellular and multicellular organisms ➢ Growth rate and generation time, Mathematical Expression of growth ➢ Bacterial growth curve ➢ Factors influencing bacterial Growth Temperature, pH Gaseous requirements, osmotic pressure a microbial groups on this basis.	7 Hrs	7 marks	**Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discus real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 Pure Culture Techniques	➢ Definition-Pure and Mixed culture ➢ Methods of isolation of Pure culture: Streak plate, pour plate and Enrichment culture ➢ Special isolation methods, Single cell isolation technique ➢ Systematic Study of pure cultures.	8 Hrs	8 marks	
Unit 4 Culture Preservation	➢ Maintenance of stock cultures ➢ Methods of preservation of pure culture: Agar slants, Saline suspension, overlaying with oil. ➢ Special methods: Glycerol stock with glass beads, liquid nitrogen Freeze drying/ Lyophilization. ➢ Introduction of Microbial cultural collection centre ATCC, ITCC, MTCC and NCIM	7 Hrs	7 marks	

References	➢ Microbiology : Pelczar, Chan, Krieg.(TMH) ➢ Text Book of Microbiology : Dubey & Maheshwari (S. Chand, Publication) ➢ Fundamental of Microbiology : Frobisher ➢ General Microbiology Vol. I & II : Power & Daginawala. (Himalaya Publication) ➢ Fundamental Principles of bacteriology: Salle, A. J. ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ Microbiology an introduction (Ninth edition) By-Tortora, Funke, Case Published by-Dorling Kindersley (India) Pvt Ltd. ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K.Maheshwari Published by-S.Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications
Model Questions	**Short Answer Questions** 1. Define reproduction and explain different types of reproduction 2. How will you calculate generation time with the help of mathematical expression 3. How will you measure cell number by Breed method 4. How will you measure cell mass by turbidity measurement 5. Discuss the effect of temperature on the growth of bacteria 6. Discuss the effect of pH on the growth of bacteria 7. Discuss the effect of gaseous requirements on the growth of bacteria 8. Define pure culture and mixed culture 9. Explain streak plate method for isolation of pure culture 10. Explain pour plate method for isolation of pure culture 11. Explain enrichment culture technique for isolation of pure culture 12. Write the long form of ATCC, ITCC, MTCCAND NCIM 13. Explain any two methods of preservation of pure culture **Long Answer Questions** 1. Discuss steps involved in growth curve 2. Explain in detail any two factors influencing bacterial growth 3. Explain any two methods for isolation of pure culture

	4. Explain in detail methods of isolation of pure culture **Multiple choice questions** 1. Pure culture is a growth of a single organism belonging to the same a) Family b) Species c) Genus d) order 2. The number of viable cell count is determined by a) Breed method b) Cell mass measurement c) Turbidity measurement d) Standard plate count 3. Shortest generation time is found in a) Maximum stationary phase b) Logarithmic death phase c) Logarithmic growth phase d) Survival phase 4. The principle involved in the streak plate method is a) Separation b) Isolation c) Streaking d) Dilution 5. What is the temperature of liquid nitrogen a) -120^0C b) -150^0C c) 0^0C d) -196^0C

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.(any two activity 5 mark each)		10 Marks
Total		20 Marks

127216 Lab Practical 3 (Minor) : Techniques of Microbial culture, Bacterial Physiology and Pure Culture							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127216	Techniques of Microbial culture, Bacterial Physiology and Pure Culture	2	60	2Hrs	25(Ext) + 25(Int)

Course Objectives	➢ To train the students in methods of microbial cultivation. ➢ To impart training of using and studying the effect of different environmental conditions on growth of bacteria. ➢ To educate the students about applying growth measurements techniques
Course Outcomes	Upon completion of this course successfully, students would be able to ➢ Use techniques of microbial cultivation. ➢ Apply the knowledge of effect of different environmental conditions on growth of bacteria for determination of physical conditions required for growth. ➢ Select and use appropriate growth measurement techniques depending on the need.

Sr. No.	**Content of Practical**	**Incorporation of Pedagogies**
1	Determination of optimum temperature for growth of bacteria	**Experiential Learning:** Hands-on experimentations. **Inquiry-Based Learning Collaborative Learning:** Group-based activities, Post-experiment discussions encourage critical evaluation. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.
2	Determination of optimum pH for growth of bacterial culture.	
3	Effects of salts/ sugar concentration on bacterial growth.	
4	Isolation of pure culture of bacteria using pour plate method	
5	Isolation of pure culture of bacteria using spread plate method	
6	Pour plate technique for viable count	
7	Cultivation of fungi on potato Dextrose Agar plates	
8	Candle jar method for cultivation of Anaerobic bacteria	
9	Slide culture technique for studying morphology of fungi.	

References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➢ AText book of Practical microbiology by Sadar and pande, Ed. Rachana Pachori(Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I &II : Power & Daginawala. (Himalaya Publication) ➢ Fundamental Principles of bacteriology: Salle, A. J. ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ Practical Microbiology (Revised edition R. C. Dubey and D. K. Maheshwari Published by-S. Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

127217 Theory 5 (Generic Open Elective Course) : Applied Microbiology for Day to Day Life							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127217	Applied Microbiology for Day to Day Life	2	30	2Hrs	30(Ext) + 20(Int)

Course Objectives

- To introduce Microbiology and its applications
- To explain the importance of cleanliness and hygiene
- To create the awareness of Microbiology in food and water safety
- To impart knowledge about fermented food preparation

Course Outcomes

Upon completion of this course successfully, students would be able to

- Illustrate the types of microorganisms , their useful and harmful activities and applications of Microbiology in various fields
- Explain the importance and measures of cleanliness and hygiene
- Describe the Microbiological concepts involved in spoilage and Preservation of food.
- Explain the role of microorganisms in food and water borne diseases
- Describe the role of microorganisms in fermented food preparation and benefits of fermented food

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 Introduction of Microbiology	➢ Definition of Microbiology and microorganisms, occurrence of mmicroorganisms. ➢ Types of Microorganisms: Bacteria, Archaea, Fungi, Algae, Protozoa and Viruses. ➢ Useful and Harmful activities of microorganisms, ➢ Applications of Microbiology in various fields.	7 Hrs	7 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance

Unit 2: Microbiology for cleanliness and hygiene	➢ Definition of the terms - Detergents, Soaps, Sanitizer, Germicide, Antibiotics and Disinfectants. ➢ Types of Chemical Antimicrobial agents, examples and applications in toothpaste, antiseptics, other cleaning agents and cosmetics. ➢ Concept and importance of hygiene. Personal hygiene, food hygiene, hospital hygiene, community hygiene. ➢ Disposal of domestic Waste: Types of waste and waste segregation, Management and Practices for waste disposal	8 Hrs	8 Marks	understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 Microbiology for safe food and water	➢ Types of food and Role of microorganisms in spoilage of food Storage and Preservation of food ➢ Common Food borne diseases and their preventive measures. ➢ Common water borne diseases. ➢ Storage, handling and Sanitization of water.	8 Hrs	8 Marks	
Unit 4 Fermented food	➢ Define fermented food. ➢ Role of microorganisms in making fermented food. ➢ Types of fermented food and their benefits ➢ Outline of some fermented food production method: Bread, Cheese, Idli and Dhokla. ➢ Probiotics(Curd, Yoghurt)	7 Hrs	7 Marks	

References	➢ Adams. M.R. and Moss, M. (1996). Food Microbiology. New Age International P. Ltd. New Delhi Anastassiadis, S. (2007). L-Lysine Fermentation. Recent Patent on Biotechnol. 1:11-24 A ➢ Bender K.S., Buckley D. H., Stahl D. A., Sattley W. M. And Madigan M. T. (2017). Brock Biology of Microorganisms. E-Book, Global Edition. United Kingdom: Pearson Education. ➢ Dubey H. C. (2004). A textbook of fungi, bacteria and Viruses. Vikas Publishing House Private Limited. New Delhi, India ➢ Dubey R. C. and D. K. Maheshwary. (2012). A textbook of Microbiology. S Chand and Company. New Delhi, India ➢ Lagerkvist U. (2003). Pioneers of Microbiology and The Nobel Prize. Singapore: World Scientific Publishing Company. ➢ Mehrotra R. S. (2009). Principles of Microbiology. India: McGraw-Hill Education (India) Private Limited. ➢ Mishra B. B. and Nayak S. K. (2020). Frontiers in Soil and Environmental Microbiology. United States: CRC Press. ➢ Pareek R. P. and Pareek N. (2019). Agricultural Microbiology. Scientific Publishers, Jodhpur, Rajasthan, India ➢ Wood, S., Williams, S.T. and White, W.R. (1983). Microbes as a source of earthy flavours in potable water – a review. Intl. Biodeterioration Bull. 19, 83–87.
Model Questions	**Short Answer Questions** 1. Define microbiology. 2. What are the different types of microorganisms? 3. Define sanitizer, Disinfectant, Detergent and Antibiotic 4. What are the different types of household waste? 5. Write any 2 microorganisms which cause food borne diseases. 6. Write names of any 2 bacteria cause spoilage of foods. 7. Write names and causative agent of any 2 water borne diseases. 8. Which microorganism is used mostly in bakery? 9. Which microorganism is called as baker's yeast? 10. Define probiotics.

Long Answer Questions

1. Write the application of Microbiology in various fields
2. Write any Five Beneficial and five harmful activities of microorganisms.
3. Define chemical microbial agents and its application.
4. Explain hygiene. How to maintain personal hygiene, food hygiene and hospital hygiene
5. Write down management and practices of waste disposal.
6. Write down the role of microorganisms in spoilage of foods.
7. Common food borne diseases and their preventive measures.
8. Write different water borne diseases and their preventive measures.
9. Role of microorganisms in making fermented foods.
10. Different fermented foods and outline of their production.

Multiple choice questions

1. --------is microorganisms mostly photosynthetic in nature

   A. Bacteria. B. Archea C. Fungi. D. Algae.

2. Alcoholic fermentation is carried out by which of the following yeast

   A. *Lactobacillus.* B. *Escherichia coli.*

   C. *Bacillus.* D. *Saccharomyces cerevisiae*

3. ----------is responsible for typhoid fever.

   A. *Salmonella typhi*. B. *E. Coli*.

   C. *P.fluorescens* D. *Saccharomyces cerevisiae*

4. Pathogens can be killed by_____.

   A.chlorination B. nitrification.

   C. Oxidation D. None of these

5. Curd is formed with the help of..... bacteria.

   A. *Bacteria*. B. *Lactic acid* C. *Lactobacillus acidophilus* D. *Yeast*

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 base on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 test</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 base on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.
(any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

127218 VSC :Lab Practical 7 : Microbial cultivation and Culture Preservation							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	127218	Microbial cultivation and Culture Preservation	2	60	2Hrs	50 (Int)

Course Objectives	➢ To train the students in methods of isolation of pure culture of bacteria. ➢ To impart training of isolation of actinomycetes, moulds, yeast and bacteria using appropriate methods and media. ➢ To educate the students about applying techniques for maintenance and preservation of microbial cultures.
Course outcomes	Upon completion of this course successfully, students would be able to ➢ Use techniques of pure culture isolation. ➢ Use isolation and cultivation techniques for bacteria and fungi. ➢ Make use of culture preservation methods.

Sr. No.	**Content of Practical**	**Incorporation of Pedagogies**
1	Cultivation of fungi on potato dextrose agar plates and in liquid medium	**Experiential Learning:** Hands-on experimentations. **Inquiry-Based Learning Collaborative Learning:** Group-based activities, Post-experiment discussions encourage critical evaluation. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.
2	Slide culture technique for studying morphology of fungi.	
3	Measurement of fungal growth by colony diameter method	
4	Measurement of fungal growth by mycelial dry weight method	
5	Isolation of Algae from soil	
6	Isolation of Actinomycetes from soil	
7	Isolation of yeast from sugary starchy material	
8	Maintenance of bacterial pure culture by sub culturing	
9	Bacterial Pure culture preservation in glycerol and glass beads	
10	Fungal Culture preservation in mineral oil	

References	➢ Microbiology, A laboratory manual by james D. cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology (Revised edition R. C. Dubey and D.K. Maheshwari Published by-S.Chand ➢ A Text book of Practical microbiology by Sadar and Pande,Ed. Rachana Pachori(Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I &II: Power &Daginawala. (Himalaya Publication) ➢ Fundamental Principles of bacteriology: Salle, A.J. ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

B. Sc. II Semester III (NEP)

127219: Course Category: Field Project (FP)/Community Engagement and Service (CES) of Microbiology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	127219	FP/ CEP in Microbiology – I	2	60	--	50(Int)

Course Objectives:	The intended objectives are: ➢ To provide practical, real-world experience, in their field of study, allowing them to apply theoretical knowledge to real-world situations or address Real-World Problems. ➢ To enhance research, interpretation and analytical skills, strengthening their critical thinking and problem-solving abilities. ➢ To foster engagement with specific microbiology related issues concerned with society, environment or agriculture etc. ➢ To Improve Collaboration, Communication among students, facilitate knowledge transfer from lab to land and get self-inspiration for contribution to the society by applying the subject knowledge.
Course Outcomes:	Upon successful completion of this course: ➢ Students will be developed regarding practical and technical skills and a deeper understanding of their subject matter and how it applies to real-world situations. ➢ They will learn to identify, analyze, and interpret complex problems using their knowledge and will develop research skills. ➢ Students will gain insight into social issues and the role of various governmental and non-government organizations (NGO) for the welfare of people and explore new ideas and approaches. ➢ They will learn to work effectively in teams and collaborate with others to achieve common goals and contributing to resolve community's problems & challenges related with the subject.

As per NEP 2020, students of B Sc. II of Semester III need to perform a Field Project (FP)/ Community Engagement and Service (CES) for TWO (2) credits i.e. 50 Marks. The guidelines/ SOP regarding the FP/CES are as follows:

1) The total time allocation for the student to carry out FP/CES is 60 hours.
2) Students should participate in FP/CES under the supervision of faculty.
3) Assigning the FP/CES topics to individual students or groups of students (4 to 5 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
4) CES may include awareness programs, public talk/ lectures, workshops, blood testing camps, vaccination drives in collaboration, surveys etc.
5) Field project may be undertakes to include survey/ laboratory work/ data analysis/ field work or in combination of these which involves practical application of knowledge and skills to address a specific problem or issue within microbiological context such as health, sustainable environment, agriculture etc.
6) For a SURVEY based FP/CES, related questionnaire (15 or more questions) should be prepared. The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
7) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc. The report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.) Submit the project report with the Guide's signature to the department.
8) Students should maintain the documentation and record properly which includes dairy, photographs, certificates, feedback of beneficiaries, news in local paper if any.
9) A CES report should be written individually in the standard format (2 Copies): Index, Introduction, details of activities, photographs, signature sheets of beneficiaries, feedback of beneficiaries, own feedback, summary /output, etc. It should be submitted with the Guide's signature to the department.
10) The oral /poster presentation for all the FP/CES should be arranged in the department. To evaluate the project, examiner should be appointed by HOD.
11) The total work for FP/CES including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

12) Some Suggested Field-Based and Conservation-Oriented Activities:

1. Environmental Sample Collection
2. Water Quality Assessment
3. Soil Microbiology Studies
4. Industrial and Agricultural Visits
5. Public Health Field Visits
6. Microbial Biodiversity Documentation
7. Environmental Monitoring
8. Waste Management
9. Bioremediation Studies
10. Sustainable Agriculture
11. Conservation Awareness Programs

References	1. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 2. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program 3. https://afribary.com/blog/1785/recent-microbiology-research-topics-for-undergraduates 4. https://www.iprojectmaster.com/final-year-projects-materials/micro-biology
Model Questions:	**Not Applicable**

Distribution of Marks and the scheme of FP/CES Evaluation as follow:

Sr. No	Evaluation base on	Marks
1	Student performance	20
2	FP/CES Report	20
3	Presentation (PPT or Poster)	10
	Total	**50**

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years- Six Semesters Bachelor's Degree Programme)

SECOND YEAR: SEMESTER – IV

Programme: B.Sc.(Microbiology)

Course: B.Sc. II Semester IV

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major Microbiology 127	Theory- 5	127220	Medical Microbiology
		Theory- 6	127221	Immunology & Serology
		Theory-7	127229	Microbiology for public health
		Lab/ Practical-8	127222	Medical Microbiology and serology
b.	Minor 127	Theory- 4	127223	Clinical Microbiology
		Lab/ Practical- 4	127224	Clinical Microbiology and serology
c.	Generic/ Open Elective 127	Theory- 6	127225	Microbiology for Human Health
d.	VSC	Lab/ Practical- 9	127226	Skills for Diagnostic Microbiology
g.	AEC-English	Theory		
	AEC–MIL	Theory		
h.	FP/CES	Project	127228	FP/CES in Microbiology–II
	CC	Outdoor		

Programme: B . S c . (Microbiology)

Course: B. Sc. II Semester IV

127220 Theory 5 (Major) : Medical Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127220	Medical Microbiology	2	30	2Hrs	30(Ext)+ 20(Int)

Course Objectives	➢ To impart knowledge about the prevalent communicable diseases and of the newer emerging pathogens. ➢ To make the students aware about the symptoms, Laboratory diagnosis, and treatment for infectious diseases ➢ To understand the symptoms, Laboratory diagnosis, and treatment for Other Pathogenic Microorganisms ➢ To impart knowledge about various antibiotic susceptibility of bacterial pathogens
Course outcome	Upon completion of this course successfully, students would be able to ➢ **CO 1** Evaluate the prevalent communicable diseases of National importance and of the newer emerging pathogens. ➢ **CO 2** Determine the mode of entry and transmission of pathogen, symptoms, Laboratory diagnosis, and treatment for infectious diseases ➢ **CO 3** Determine the mode of entry and transmission of pathogen, symptoms, Laboratory diagnosis, and treatment for Other Pathogenic Microorganisms ➢ **CO 4** Evaluate the antibiotic susceptibility of bacterial pathogens

Unit System	**Contents**	**Workload Allotted in hours**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit-I Principles of Epidemiology	➢ Definition, Scope & Application of epidemiology. ➢ Incidence & prevalence rates, Mortality & Morbidity rates ➢ Define the terms- Infection, diseases, Pandemic, Endemic and Sporadic. ➢ Types of infection.	8 Hrs	8 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts.

	➢ Outline of Infection process - pathogenicity and virulence, Microbial virulence factors: toxins, enzymes ➢ Epidemiology of infectious diseases: i. Sources & reservoir of infection ii. Modes of transmission ➢ Measures for prevention of epidemics with Global health consideration			**Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit II Pathogenic bacteria	Study of following bacteria with respect to their morphology, cultural and biochemical properties, pathogenesis, laboratory diagnosis and prophylaxis. a.*Staphylococcus aureus* *b.Clostridium tetani.* *c.Salmonella typhi.* *d.Mycobacterium tuberculosis.*	7 Hrs	7 Marks	
Unit-III **Other Pathogenic Microorganisms**	Study the morphology, pathogenesis, laboratory diagnosis and prophylaxis of following microorganisms. ➢ **Viruses-** *a.* Rabies. *b.* HIV:AIDS ➢ **Fungi-** a. *C. albicans* ➢ **Parasite** *a. E. histolytica*	8 Hrs	8 Marks	
Unit-IV **Antimicrobial chemotherapy**	➢ Ideal characters of chemotherapeutic agents ➢ Basic mechanisms of antibiotic action ➢ Major antimicrobial agents and their clinical uses:	7 Hrs	7 Marks	

	a. **Antibacterial agents**: Chloramphenicol, Streptomycin b.**Antiviral agents**: Azidothymidine, Amantadine. c.**Antifungal agents**: Griseofulvin, Amphotericin B ➢ Antimicrobial susceptibility testing: Introduction to CLSI (NCCLS), MIC. Disc diffusion, Agar dilution, Broth dilution (macro and micro)			

References	➢ Microbiology : Pelczar, Chan, Krieg.(TMH) ➢ Text Book of Microbiology : Dubey & Maheshwari (S.Chand, Publication) ➢ Text Book of Microbiology: Ananthanarayan and Paniker's (Orient Longman Private Ltd., Publication, Chennai) ➢ Fundamental of Microbiology : Frobisher ➢ General Microbiology Vol. I &II : Power &Daginawala. (Himalaya Publication) ➢ Fundamental Principles of bacteriology: Salle, A. J. ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II ➢ A Textbook of Medical Microbiology: B.Sc. Second year, Sem- III, Dnyanpath publication, India
Model Questions	**Short Answer Questions** 1. Discuss scope of epidemiology and give its uses. 2. What is pathogenicity? Explain in brief toxins. 3. Explain symptoms of rabies in man. 4. Explain Lab diagnosis of Typhoid. 5. Explain Ideal characters of chemotherapeutic agents **Long Answer Questions** 1. Explain various type of Infection and modes of disease transmission in detail. 2. Define Epidemic and pandemic disease. Describe in detail control of communicable disease in human host.

	3. Describe morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Salmonella typhi*. 4. Describe in detail about *C. albicans.* 5. Explain mode of action of Antiviral agents Azidothymidine **Multiple choice questions** 1.Subsequent infection by the same parasites in the host is termed as--------- a) re-infection b) primary infection c) Iatrogenic infection d) super infection 2. Circulation of bacteria in the blood in known as---------- --. a) septicemia b) bacteraemia c) pyaemia d) supraemia 3.Hydrophobia is caused by a) HIV virus b) Hepatitis virus c) Rabies virus d) polio virus

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		20 Marks

127221 Theory 6 (Major) : Immunology & Serology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127221	Immunology & Serology	2	30	2Hrs	30(Ext)+ 20(Int)

Course Objectives	➢ Understand the principles of immunology and its classification ➢ To impart the knowledge of Immune response and Autoimmune diseases ➢ Understand the concept of Antigen, Antibody. ➢ To gain the knowledge of Antigen Antibody Reactions
Course outcome	Upon completion of this course successfully, students would be able to ➢ Illustrate the concept of Organs and Cells of Immune system and its classification ➢ Understand the concept of Immune response and different Autoimmune diseases ➢ Gain the knowledge of Antigen and Antibody ➢ Study the concept of Antigen Antibody Reactions

Unit System	**Contents**	**Workload Allotted in hours**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit-I **Basics of Immunology & classification of Immunity**	➢ Organs and cells of immune system ➢ Outline of Specific and Nonspecific factors in defense mechanism ➢ Immunity- Definition and types of immunity a.Innate Immunity - Species, Racial, Individual and Herd b.Acquired – Active and Passive Immunity	7 Hrs	7 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.

Unit II **Immune response**	➢ Outline of Immune response ➢ Antibody Mediated & Cell mediated Immunity ➢ Immune Response, Primary & Secondary Immune response ➢ Outline of Autoimmunity& auto-immune diseases (Ex. Rheumatoid Arthritis and Myasthenia Gravis)	8Hrs	8 Marks	**Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for Interactive discussions. **Concept Maps:** Ask Students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit-III **Antigen and Antibody**	➢ Antigens- Definition, types and factors determining antigenicity, Bacterial antigens. ➢ Concept of Antibodies and their structure (Immunoglobulins) ➢ Classification of Immunoglobulins, Properties and differences ➢ Monoclonal antibodies and their applications	8 Hrs	8 Marks	
Unit-IV **Antigen Antibody reactions**	➢ Agglutination-Blood grouping and WIDAL test ➢ Precipitation -VDRL Test ➢ Types of Immuno-diffusion ➢ Complement Fixation Test, ELISA and RIA	7 Hrs	7 Marks	
References	➢ Microbiology : Pelczar, Chan, Krieg.(TMH) ➢ Text Book of Microbiology : Dubey & Maheshwari (S.Chand, Publication) ➢ Fundamental of Microbiology : Frobisher ➢ General Microbiology Vol. I &II : Power &Daginawala. (Himalaya Publication)			

	➢ Text Book of Microbiology: Ananthanarayan and Paniker's (Orient Longman Private Ltd., Publication, Chennai) ➢ Fundamental Principles of bacteriology: Salle, A J. ➢ Elementary Microbiology : Modi (Akta Prakashan) Vol. I & II ➢ A Textbook of Medical Microbiology: B.Sc. Second year, Sem-III, Dnyanpath publication, India
Model Questions	**Short Answer Questions** 1. Define immunity. Give classification of immunity. 2. Define Autoimmune diseases, explain Rheumatoid arthritis 3. Differentiate in between T lymphocyte and B lymphocyte 4. Describe in brief advantages and applications of Monoclonal Antibodies. 5. Describe in brief Blood grouping. **Long Answer Questions** 1. Discuss in detail Cells of Immune system 2. Explain in detail Primary and secondary immune response. Differentiate in between Antibody mediated immunity and Cell mediated immunity 3. Describe in detail Monoclonal Antibodies 4. Describe the comparative account of five classes of immunoglobulins 5. Describe in detail precipitation reaction and its types. **Multiple choice questions** 1. Which of the following is primary lymphoid organ? a) MALT b) Thymus c) Spleen d) Lymph node. 2. Which of the following is Autoimmune disease. a) Rheumatoid arthritis b) AIDS c) Covid-19 d) Tuberculosis 3. The largest immunoglobulin molecule containing 5 monomer units is a) IgG b) IgM c) IgA d) IgD 4. Precipitation reactions involve combination of soluble antibody with: a) Soluble antigen b) Cellular antigens c) Red blood cells d) Radioactive antigen

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.(any two activity 5 mark each)		10 Marks
Total		20 Marks

127229 Theory 7 (Major): Microbiology for Public Health							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127229	Microbiology for Public Health	2	30	2Hrs	30(Ext) + 20(Int)

Course Objectives	➢ To impart knowledge about the public health and role of Microbiologist in public health. ➢ To make the students aware about microbiome and its importance ➢ To impart knowledge about role of Microbes for maintaining public health ➢ To impart knowledge about vaccines for disease prevention
Course outcome	Upon completion of this course successfully, students would be able to ➢ **CO 1** Evaluate the role of Microbiologist in public health ➢ **CO 2** Evaluate the importance of microbiome in public health ➢ **CO 3** Apply microbiological concepts to public health interventions and policy. ➢ **CO 4** Evaluate the role of vaccination in disease prevention.

Unit System	Contents	Workload Allotted in hours	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I Introduction to public health and human microbiome	➢ Definition, scope, concept and importance of public health, Role of microbiologist in public health, concept of one health ➢ Importance of human microbiome in health ➢ Factors affecting the survival and colonization of microorganisms on various organs ➢ Normal flora of skin, throat and upper respiratory tract, gastrointestinal tract and genitourinary tract.	7 Hrs	7 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures,
Unit II Microbes for maintaining public health	➢ Brief description and distinction between prebiotics, probiotics and symbiotic ➢ Probiotics for maintaining human health: prerequisite characteristics of probiotic strains, ➢ common probiotic bacterial strains,	8Hrs	8 Marks	

	modes of action of probiotics ➢ Probiotic supplementation for disease management.			assignment as homework and use class time for Interactive discussions. **Concept Maps:** Ask Students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit-III **Immunization and vaccines**	➢ Immunization : Definition and scope, Herd Immunity, National Immunization Schedule in India ➢ Vaccines : Definition and Types of Vaccine- live and killed vaccines, Conventional vaccines, peptide vaccine, subunit vaccine, genetically engineered vaccines ➢ Cold Chain and Vaccine Storage ➢ Role of Microbiologists in monitoring vaccine-preventable disease outbreaks; Vaccine development and testing; Public health education and awareness	8 Hrs	8 Marks	
Unit-IV **Key Vaccination Campaigns in India**	➢ Pulse Polio Programme ➢ Mission Indradhanush (2014 onward) ➢ COVID19 Vaccination Drive: (CoWIN) portal-based registration, ➢ Measles-Rubella Campaign National Viral Hepatitis Control Programme	7 Hrs	7 Marks	

References	➢ Tulchinsky, T. H., &Varavikova, E. A. (2014). The new public health. Academic Press. ➢ Friis, R. H., & Sellers, T. (2020). Epidemiology for public health practice. Jones & Bartlett Learning. ➢ Schneider, M.J. (2020). Introduction to public health . Jones & Bartlett Learning. ➢ Basic Immunology by Joshi and Osarano. Agrobotanical publishers Ltd. Bikaner. ➢ Medical Microbiology. N. C. Dey and T. K. Dey. Allied agency, Culcutta.

	➢ Molecular biology by David Freifelder, Narosa Publishing house, New Delhi. ➢ Parks textbook of preventive and social medicine, K. Park,BanarsidasBhanot Publishers, Jabalpur, India
Model Questions	**Short Answer Questions** 1. List three primary roles of a microbiologist in public health. 2. How does the gut microbiome aid in human nutrition and metabolism? 3. Name two dominant bacterial species found as normal flora on human skin. 4. What is "dysbiosis" and what is its effect on the host? 5. Identify four physiological or environmental factors that affect the colonization of microorganisms in the body. 6. Why is *Lactobacillus* important in the normal flora of the genitourinary tract? 7. What is the difference between transient flora and resident normal flora? 8. State two ways in which the normal flora provides protection against external pathogens. 9. Define Public Health. 10. Differentiate between resident flora and transient flora 11. Define the term prebiotic. 12. What are symbiotic? 13. Define Immunization and explain its broad scope in public health. 14. List the mandatory vaccines given at birth under the Universal Immunization Programme (UIP) in India. 15. Write short notes on Peptide Vaccines and Subunit Vaccines. 16. What is the fundamental difference between conventional vaccines and genetically engineered (recombinant) vaccines? 17. What is the primary target age group for the Pulse Polio Programme in India? 18. When and why was Mission Indradhanush launched? **Long Answer Questions** 1. Define public health. What is the fundamental scope and importance of public health microbiology? 2. Explain the concept of "One Health" and discuss how microbiologists contribute to this framework. 3. How do public health microbiologists coordinate with epidemiologists and environmentalists to investigate disease outbreaks?

4. Describe the human microbiome and its role in maintaining host homeostasis and regulating immune function.
5. What are the key microorganisms found in the normal flora of the upper respiratory tract?
6. Describe the critical prerequisite characteristics that a microbial strain must possess to be classified as an effective probiotic
7. Differentiate between prebiotics, probiotics, and symbiotic. Discuss how each functions within the human gut ecosystem.
8. What is a vaccine cold chain? Explain the various storage equipment, temperature ranges, and the role of the Electronic Vaccine Intelligence Network (eVIN) in maintaining vaccine potency.
9. Describe the vital role of microbiologists in monitoring outbreaks of vaccine-preventable diseases. How do they contribute to vaccine development and efficacy testing?
10. Describe different types of vaccines with their advantages and disadvantages
11. Discuss how technology and digital platforms were utilized during India's COVID-19 Vaccination Drive.
12. Explain the importance of the Measles-Rubella Elimination Campaign. What measures are being taken to achieve total elimination?

Multiple choice questions

1. According to the FAO/WHO, which of the following is NOT a mandatory criterion to qualify a microorganism as a probiotic?

   A) It must be sufficiently characterized at the strain level.

   B) It must be alive in the product at an efficacious dose throughout its shelf life.

   C) It must be derived entirely from human breast milk.

   D) It must be proven safe and supported by human clinical trials.
2. Which of the following is a primary mode of action by which probiotics exclude harmful pathogens?

   A) Secreting broad-spectrum antibiotics

   B) Competitive exclusion for mucosal binding sites and nutrients

   C) Lowering blood glucose levels directly

   D) Inhibiting human digestive enzyme production

	3. Which of the following bacterial genera is widely utilized in probiotic formulations? A) *Escherichia* B) *Bifidobacterium* C) *Salmonella* D) *Staphylococcus* 4. What is the primary update in the ISAPP's updated definition of a synbiotic? A) It is defined as any supplement containing both fiber and bacteria. B) It is a mixture of live microorganisms and substrate(s) selectively utilized by host microorganisms that confers a health benefit. C) It must consist strictly of plant-based prebiotics. D) It applies only to treatments of the lower gastrointestinal tract. 5. Which of the following metabolites, produced by the fermentation of prebiotics by gut microbiota, provides energy for colonocytes and lowers luminal pH? A) Short-chain fatty acids (SCFAs) B) Bile salts C) Amino acids D) Immunoglobulins 6. Which of the following is an example of a live-attenuated vaccine included in the Universal Immunization Programme (UIP)? A) Hepatitis B B) Tetanus Toxoid C) BCG D) Inactivated Polio Vaccine (IPV) 7. Which of the following vaccines uses genetically engineered recombinant technology? A) Hepatitis B vaccine B) Oral Polio Vaccine C) BCG vaccine D) DTwP vaccine 8. What is the primary role of a clinical microbiologist during a vaccine-preventable disease outbreak? A) Designing the vaccine cold chain transport routes

	B) Isolating pathogens, confirming the diagnosis, and conducting serological surveillance C) Procuring vaccine stocks from international vendors D) Administering vaccines to the affected population 9. Which of the following is the key focus of the National Viral Hepatitis Control Programme? A) Mass immunization of infants against Polio B) Elimination of Hepatitis B and Hepatitis C C) Registration for COVID-19 vaccines D) Eradication of Measles 10. What is the primary target age group for children under India's Pulse Polio Programme? A) 0 to 1 year B) 0 to 5 years C) 5 to 10 years D) Up to 15 years 11. What does the CoWIN portal, utilized during the COVID-19 vaccination drive, stand for? A) Corona Virus Immunization Network B) COVID Vaccine Intelligence Network C) Covid Operations and Vaccination Information Network D) Corona Web-based Immunization Node

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.(any two activity 5 mark each)		10 Marks
Total		20 Marks

127222 Lab Practical 8 (Major) : Medical Microbiology and Serology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127222	Medical Microbiology and serology	2	60	2Hrs	25(Ext) + 25(Int)

Course Objectives

- To study Isolation and Identification of bacteria
- To gain the knowledge about Biochemical Tests and Enzyme study
- To study the concept of different serological Tests
- To study the Antibiotic sensitivity in Microbiology

Course Outcomes

Upon completion of the course, the student would be able to:

- CO 1 Isolate and identify the bacteria
- CO 2 perform different Biochemical Tests
- CO 3 Perform the different serological Tests
- CO 4 understand the Antibiotic Sensitivity and resistance pattern

Sr. No.	Contents of Practical
1.	Morphology and cultural characteristics of *S.aureus* (Gram staining & Motility)
2.	Morphology and cultural characteristics of *E.coli* (Gram staining & Motility)
3.	IMViC characteristics of *Staphylococcus aureus*
4.	IMViC characteristics of *Escherichia coli*
5	Carbohydrate Fermentation test for differentiation of bacterial cultural
6	To study the Enzyme Catalase
7	To study the Enzyme Urease
8	To perform Blood Grouping Test
9	To perform VDRL Test
10	Antibiotic Sensitivity by Disc Diffusion Technique
Incorporation of Pedagogies	• **Experiential Learning:** Hands-on experimentations. • **Inquiry-Based Learning** • **Collaborative Learning:** Group-based activities, Post-experiment discussions encourage critical evaluation. • **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.

References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ https://ivl1-au.vlabs.ac.in/exp/direct-elisa/simulation.html for immunology and microbiology ➢ Practical Microbiology (Revised edition R.C.Dubey and D.K.Maheshwari Published by-S. Chand ➢ Microbes in Action :Seely, Wander Mark Tarporewala, Bombay ➢ A Manual of Microbiology: A.J. Salle. ➢ Bacteriological Techniques :F.J.Baker ➢ Introduction to Microbial Techniques :Gunasekaran ➢ Laboratory Fundamentals of Microbiology: Alcamo, I.E., Jones and Bartlett Publishers. ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by-S.Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

127223 Theory 4 (Minor) : Clinical Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127223	Clinical Microbiology	2	30	2Hrs	30(Ext) + 20(Int)

Course Objectives

- To impart knowledge about the prevalent communicable diseases and of the newer emerging pathogens.
- To make the students aware about the symptoms, Laboratory diagnosis, and treatment for infectious diseases
- To understand the symptoms, Laboratory diagnosis, and treatment for Other Pathogenic Microorganisms
- To impart knowledge about various antibiotic susceptibility of bacterial pathogens

Course Outcomes

Upon completion of this course successfully, students would be able to

- **CO 1** Evaluate the prevalent communicable diseases of National importance and of the newer emerging pathogens.
- **CO 2** Determine the mode of entry and transmission of pathogen, symptoms, Laboratory diagnosis, and treatment for infectious diseases
- **CO 3** Determine the mode of entry and transmission of pathogen, symptoms, Laboratory diagnosis, and treatment for Other Pathogenic Microorganisms
- **CO 4** Evaluate the antibiotic susceptibility of bacterial pathogens

Unit System	Contents	Workload Allotted in hours	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I **Principles of Epidemiology**	➢ Definition, Scope & Application of epidemiology. ➢ Define the terms- Infection, Diseases, Pandemic, Endemic and Sporadic ➢ Epidemiology of infectious diseases: • Sources & reservoir of infection • Modes of transmission ➢ Measures for prevention of epidemics with Global health consideration	7Hrs	7 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and Simulations to enhance understanding of

Unit-II **Basics of Immunology & Immunity**	➢ Outline of Specific and Nonspecific factors in defense mechanism ➢ Immunity- Definition and types a) Innate Immunity - Species, Racial, Individual, Herd b) Acquired – Active and Passive Immunity	8 Hrs	8 Marks	the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit-III **Antigen and Antibody classification**	➢ Antigens- Definition, and factors determining antigenicity ➢ Concept and structure of Antibodies (Immunoglobulins)- ➢ Classification of Immunoglobulins ➢ Antigen Antibody reactions- Agglutination and Precipitation reactions	8 Hrs	8Marks	
Unit-IV **Pathogenic bacteria and Antimicrobial chemotherapy**	➢ Study of following bacteria with respect to their morphology, cultural and biochemical properties, pathogenesis, laboratory diagnosis and prophylaxis. *Staphylococcus aureus, Salmonella typhi* ➢ Ideal characters of chemotherapeutic agents ➢ Basic mechanism of antibiotic action, Major antimicrobial agents and its clinical uses: Chloramphenicol, Azidothymidine. Griseofulvin, ➢ Antimicrobial susceptibility testing: Disc diffusion technique	7 Hrs	7 Marks	

<table>
<tr><td>References</td><td>

Microbiology : Pelczar, Chan, Krieg.(TMH)
Text Book of Microbiology : Dubey & Maheshwari (S.Chand, Publication)
Fundamental of Microbiology : Frobisher
Text Book of Microbiology: Ananthanarayan and Paniker’s (Orient Longman Private Ltd., Publication, Chennai)
General Microbiology Vol. I &II: Power & Daginawala. (Himalaya Publication)
Fundamental Principles of bacteriology: Salle, A. J.
Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II
A Textbook of Medical Microbiology: B.Sc. Second year, Sem-III, Dnyanpath publication, India

</td></tr>
<tr><td>Model Questions</td><td>
Short Answer Questions

Discuss scope of epidemiology and give its uses.
What is pathogenicity? Explain in brief toxins.
Define antigen.
Explain the types of antibodies.
Explain Ideal characters of chemotherapeutic agents

Long Answer Questions

Explain various type of Infection and modes of disease transmission in detail.
Define Epidemic and pandemic disease. Describe in detail control of communicable disease in human host.
Explain air as a mode of transmission of infection.
Explain agglutination reaction with proper examples.
Explain mode of action of Antiviral agents Azidothymidine

Multiple choice questions
1. Subsequent infection by the same parasites in the host is termed as--------
a) re-infection b) primary infection
c) Iatrogenic infection d) super infection
2. Circulation of bacteria in the blood in known as----------.
a) septicemia b) bacteraemia c) pyaemia d) supraemia
3. The immunoglobulin which can cross placenta is
a) Ig A b) IgG c) IgD d) IgE
</td></tr>
</table>

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		20 Marks

127224 Lab Practical 4 (Minor) :Clinical Microbiology And Serology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127224	Clinical Microbiology and serology	2	60	2Hrs	25(Ext) + 25(Int)

Course Objectives

- To study Isolation and Identification of bacteria
- To gain the knowledge about Biochemical Tests and Enzyme study
- To study the concept of different serological Tests
- To study the Antibiotic sensitivity in Microbiology

Course Outcomes

Upon completion of the course, the student would be able to:

- CO 1 Isolate and identify the bacteria
- CO 2 perform different Biochemical Tests
- CO 3 Perform the different serological Tests
- CO 4 understand the Antibiotic Sensitivity and resistance pattern

Sr. No.	Contents of Practical
1	Morphology and cultural characteristics of *S.aureus* (Gram staining & Motility)
2	Morphology and cultural characteristics of *E.coli* (Gram staining & Motility)
3	IMViC characteristics of *Staphylococcus aureus*
4	IMViC characteristics of *Escherichia coli*
5	Carbohydrate Fermentation test for differentiation of bacterial cultural
6	To study the Enzyme Catalase
7	To study the Enzyme Urease
8	To perform Blood Grouping Test
9	To perform VDRL Test
10	Antibiotic Sensitivity by Disc Diffusion Technique
Incorporation of Pedagogies	• **Experiential Learning:** Hands-on experimentations. • **Inquiry-Based Learning** • **Collaborative Learning:** Group-based activities, Post-experiment discussions

	encourage critical evaluation. • **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.
References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ A textbook of Practical Microbiology (B Sc. Sem 1 &2) : Dr. R. R. Pachori, P.S. Sadar, Dr. A. M. Pande, 2nd Edition. ➢ Microbes in Action: Saley, Wander Mark Tarporewala, Bombay ➢ A Mannual of Microbiology: A.J. Salle. ➢ Microbiology Methods : Collins ➢ Bacteriological Techniques :F.J. Baker ➢ Introduction to Microbial Techniques :Gunasekaran ➢ Laboratory Fundamentals of Microbiology: Alcamo, I.E., Jones and Bartlett Publishers. ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by-S.Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

127225 Theory6 (Generic Open Elective Course) : Microbiology for Human Health							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127225	Microbiology for Human Health	2	30	2Hrs	30(Ext) + 20(Int)

Course Objectives

- To impart students' knowledge about infectious diseases
- To make the students aware about the ways of spreading diseases in community
- To impart students' knowledge about importance of vaccination
- To apply the knowledge of chemotherapy

Course Outcomes

Upon completion of this course successfully, students would be able to

- CO 1 : Illustrate the infectious diseases
- CO 2 : Illustrate the importance of normal flora and use of pre and probiotics
- CO 3 : Understand the knowledge of the chemotherapeutic agent
- CO 4 : Aware about importance of vaccination

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 Infectious diseases and their mode of transmission	➢ Concept of infection and diseases. ➢ Terms used in epidemiology with their examples Epidemics, endemic sporadic, bacteremia, septicemia, toxemia ➢ Source of infection and mode of transmission of infectious disease. ➢ Prevention and control of communicable diseases.	7 Hrs	7 Marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: Models/ Charts. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.

Unit 2 Interaction of human body with microbes	➢ Terms used-pathogen, parasite, virulence, commensal. ➢ Concept of normal flora of human body with examples. ➢ Importance of normal flora ➢ Use of pre and probiotics.	8 Hrs	8 Marks	**Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 Chemotherapeutic agents	➢ Definition and examples of antibiotics. ➢ Proper use of antibiotics, other anti-microbial agents and their clinical uses. ➢ Problem of anti-microbial resistance and hazards caused by it, measures to combat antimicrobial resistance.	8 Hrs	8 Marks	
Unit 4 Immunity and vaccines	➢ Outline of immune system and concept of immunity, antigen, antibody, immune response. ➢ Outline of specific and non-specific defense mechanism of human body. ➢ Vaccines for disease prevention. Vaccine and their types. ➢ Schedule of vaccination. ➢ General measures for building strong immune system.	7 Hrs	7 Marks	

References	➢ Microbiology : Pelczar, Chan, Krieg.(TMH) ➢ Text Book of Microbiology : Dubey & Maheshwari (S.Chand, Publication) ➢ Text Book of Microbiology: Ananthanarayan and Paniker's (Orient Longman Private Ltd., Publication, Chennai) ➢ Fundamental of Microbiology : Frobisher ➢ General Microbiology Vol. I &II : Power &Daginawala (Himalaya Publication) ➢ Fundamentals Principles of bacteriology: Salle, A.J. ➢ Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II
Model Questions	**Short Answer Questions** 1. Explain concept of infectious diseases 2. What is importance of normal flora in human body? 3. Write the use of pre and probiotics 4. Explain antimicrobial agents **Long Answer Questions** 1. Explain the mode of transmission of diseases 2. Write the prevention and control of communicable diseases 3. Write about immune system and concept of immunity 4. Explain vaccines for disease prevention **Multiple choice questions** 1 .....is the study of the distribution ,causes and control of diseases in populations 2 .....are used to treat infections caused by bacteria fungi or other microorganism 3. The long form of WBC is..... 4 .....is considered one of the most effective ways to prevent infectious diseases

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. two activity 5 mark each)		10 Marks
Total		20 Marks

127226 Vocational Skill Course (VSC) Lab Practical 9 : Skills for Diagnostic Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	127226	Skills for Diagnostic Microbiology	2	60	2Hrs	50(Int)

Course Objectives	➢ To study Isolation and Identification of bacteria from clinical samples ➢ To gain the knowledge about Blood culture technique ➢ To study the concept of different serological Tests and various diagnosis method use in microbiology laboratory. ➢ To study the antibiogram (antibiotic susceptibility) of clinical isolate ➢ To gain the knowledge about Advanced tools and techniques used in diagnostic microbiology laboratory
Course outcomes	Upon completion of this course successfully, students would be able to ➢ CO 1 isolate and identify the bacteria from clinical samples ➢ CO 2 understand the Blood culture technique ➢ CO 3 Perform the different serological tests various diagnosis method use in microbiology laboratory. ➢ CO 4 understand the antibiogram (antibiotic susceptibility) of clinical isolate ➢ CO5 understand the importance of advanced tools and techniques used in diagnostic microbiology laboratory
Sr. No.	**Content of Practical**
1	Laboratory Techniques for collection of clinical specimen: Blood, Urine, Pus, Sputum, Stool and CSF
2	Isolation and identification of pathogenic microorganisms from various clinical samples i) *E.coli* ii) *S.aureus* iii) *P.vulgaris*
3	Blood culture technique for identification of pathogenic bacteria
4	To perform routine Physical, Chemical and microscopic examination of urine
5	Study of Antibiogram (Antibiotic Sensitivity) of clinical isolate of pathogen using appropriate discs.
6	Laboratory diagnosis of typhoid by Widal Test
7	Sputum Test for diagnosis of Tuberculosis (Acid Fast Stain)
8	Demonstration of *T. pallidum* using Dark Field Microscopy

9	Advanced tools and techniques used in Diagnostic Microbiology Laboratory 1. ELISA – ELISA Reader 2. Real Time PCR 3. Automated bacterial identification system
10	Educational Visit to Diagnostic Microbiology Laboratory
Incorporation of Pedagogies	• **Experiential Learning:** Hands-on experimentations. • **Inquiry-Based Learning** • **Collaborative Learning:** Group-based activities, Post-experiment discussions encourage critical evaluation. • **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.
References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication. ➢ https://ivl1-au.vlabs.ac.in/exp/direct-elisa/simulation.html for immunology and microbiology ➢ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➢ Microbiology Methods : Collins ➢ Bacteriological Techniques :F.J.Baker ➢ Introduction to Microbial Techniques :Gunasekaran ➢ Laboratory Fundamentals of Microbiology: Alcamo, I.E., Jones and Bartlett Publishers. ➢ Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand ➢ Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

B. Sc. II Semester IV (NEP)

127228: Course Category- Field Project (FP)/Community Engagement and Service (CES) of Microbiology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	127228	(FP/ CEP in Microbiology - II)	2	60	--	50(Int)

Course Objectives:	The intended objectives are: • To provide practical, real-world experience, in their field of study, allowing them to apply theoretical knowledge to real-world situations or address Real-World Problems. • To enhance research, interpretation and analytical skills, strengthening their critical thinking and problem-solving abilities. • To foster engagement with specific microbiology related issues concerned with society, environment or agriculture etc. • To Improve Collaboration, Communication among students, facilitate knowledge transfer from lab to land and get self-inspiration for contribution to the society by applying the subject knowledge.
Course Outcomes:	Upon successful completion of this course: • Students will be developed regarding practical and technical skills and a deeper understanding of their subject matter and how it applies to real-world situations. • They will learn to identify, analyze, and interpret complex problems using their knowledge and will develop research skills. • Students will gain insight into social issues and the role of various governmental and non-government organizations (NGO) for the welfare of people and explore new ideas and approaches. • They will learn to work effectively in teams and collaborate with others to achieve common goals and contributing to resolve community's problems & challenges related with the subject.

As per NEP 2020, students of B Sc. II of Semester IV need to perform a Field Project (FP)/ Community Engagement and Service (CES) for TWO (2) credits i.e. 50 Marks. The guidelines/ SOP regarding the FP/CES are as follows:

1. The total time allocation for the student to carry out FP/CES is 60 hours.
2. Students should participate in FP/CES under the supervision of faculty.
3. Assigning the FP/CES topics to individual students or groups of students (4 to 5 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
4. CES may include awareness programs, public talk/ lectures, workshops, blood testing camps, vaccination drives in collaboration, surveys etc.
5. Field project may be undertakes to include survey/ laboratory work/ data analysis/ field work or in combination of these which involves practical application of knowledge and skills to address a specific problem or issue within microbiological context such as health, sustainable environment, agriculture etc.
6. For a SURVEY based FP/CES, related questionnaire (15 or more questions) should be prepared.

   The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
7. A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc. The report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.) Submit the project report with the Guide's signature to the department.
8. Students should maintain the documentation and record properly which includes dairy, photographs, certificates, feedback of beneficiaries, news in local paper if any.
9. A CES report should be written individually in the standard format (2 Copies): Index, Introduction, details of activities, photographs, signature sheets of beneficiaries, feedback of beneficiaries, own feedback, summary /output, etc. It should be submitted with the Guide's signature to the department.
10. The oral /poster presentation for all the FP/CES should be arranged in the department. To evaluate the project, examiner should be appointed by HOD.
11. The total work for FP/CES including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

12. Some Suggested Field-Based and Conservation-Oriented Activities:

1. Environmental Sample Collection
2. Water Quality Assessment
3. Soil Microbiology Studies
4. Industrial and Agricultural Visits
5. Public Health Field Visits
6. Microbial Biodiversity Documentation
7. Environmental Monitoring
8. Waste Management
9. Bioremediation Studies
10. Sustainable Agriculture
11. Conservation Awareness Programs

References	• https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf • https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program • https://afribary.com/blog/1785/recent-microbiology-research-topics-for-undergraduates • https://www.iprojectmaster.com/final-year-projects-materials/micro-biology
Model Questions:	**Not Applicable**

Distribution of Marks and the scheme of FP/CES Evaluation as follow:

Sr. No	Evaluation base on CAT	Marks
1	Student performance	20
2	FP/CES Report	20
3	Presentation (PPT or Poster)	10
	Total	**50**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: MICROBIOLOGY

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027)
Under Uniform NEP 2020

SYLLABUS

Semester - V and VI

Sant Gadge Baba Amravati University, Amravati

FACULTY: Science and Technology (2 credits-50 marks major-minor)

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years: Six Semesters Bachelor's Degree Programme)

THIRD YEAR: SEMESTER - V

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major Microbiology 127	Theory- 8	127230	Microbial Ecology & Environmental Microbiology
		Theory- 9	127231	Biochemistry & Metabolism
		Theory- 10	127232	Fundamentals of Industrial Microbiology
		Lab/ Practical-10	127233	Biochemistry & Environmental Microbiology
	Major Elective 127	Theory 1 DSE 1	127234	Fermentation Technology
		Lab/ Practical DSE 1	127235	Fermentation Technology
		OR		
		Theory 2 DSE 2	127236	Agriculture Microbiology, Bioinstrumentation and Biostatistics
		Lab/ Practical-DSE-2	127237	Agriculture Microbiology, Bioinstrumentation and Biostatistics
	Minor 127	Theory-5	127238	Environmental Microbiology and Biomolecules
		Lab/ Practical-5	127239	Environmental Microbiology and Biomolecules
b.	Generic/OE	-	-	-
c.	VSC	Lab/ Practical-11	127240	Water Analysis for Environmental Monitoring
	SEC	Lab/ Practical-12	127241	Microbial Fermentation
d.	VEC	-	-	-
e.	FP/CES	Project	127242	FP/ CEP in Microbiology
	Non- credit	Non- credit	-	Foundation of Artificial Intelligence

Programme: B.Sc. (Microbiology)

Course : **B.Sc. III Semester V**

127230 Theory 8 (Major): Microbial Ecology and Environmental Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127230	Microbial Ecology and Environmental Microbiology	2	30	2 Hrs	30(Ext) + 20 (Int)

Course Objectives

- To impart knowledge about ecology and environment.
- To make the students understand the various types of interactions in environment.
- To impart knowledge about role of microbes in maintaining biogeochemical cycles in the nature.
- To make the student understand different types of microorganisms in air, water and soil

Course Outcomes

- Upon completion of this course successfully, students would be able to
- Illustrate the different habitats of microorganisms in nature
- Apply the knowledge for prevention of diseases caused by air and water
- Select appropriate method for treatment of water
- Apply the techniques for microbiological analysis of air

Unit System	**Contents**	**Workload allotted**	**Weight age of Marks Allotted**	**Incorporation of Pedagogies**
Unit 1 Microbial Ecology	➢ Ecology: Introduction and Definition ➢ Types of microorganism based on oxygen requirement: Aerophiles, Microaerophiles, Anaerobic bacteria. Based on carbon requirement (Methanotrophs, Methylotrophs, Capnophiles) ➢ Microbial Association:	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model, Charts. **Problem-Solving Sessions**: Organize

	Positive Association, Negative Association, Neutral Association. ➢ Extremophiles: Types, Adaption and applications of extremophiles			regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical
Unit 2 Soil Microbiology	➢ Microorganisms in soil and their significance: bacteria fungi, algae, protozoa, rhizosphere and rhizoplane. ➢ Decomposition of plant and animal residues in soil ➢ Definition, formation, function and Microbiology of Humus ➢ Biogeochemical Cycle: outline of Nitrogen cycle & Carbon cycle.	7 Hrs	7 marks	
Unit 3 Water Microbiology	➢ Planktons: Definition , and control, concept of Eutrophication ➢ Treatment of water: Aeration, Coagulation, Flocculation, Sedimentation and filtration ➢ Methods of Chlorination: plain, super chlorination, ammonia chlorine treatment, Break point chlorination.	8 Hrs	8 marks	

	➢ Water borne diseases: Etiology, symptoms and prevention of Cholera, Typhoid, Hepatitis.			knowledge. **Any other innovative pedagogy as applicable.**
Unit 4 Air Microbiology	➢ Different types of microorganisms in air and its control ➢ Techniques for Microbiological analysis of air: Solid impingement devices (Anderson air sampler, Membrane filter technique) ➢ Liquid impingement devices, (Capillary impingement device, Lemon's air sampler) ➢ Air borne diseases: Etiology, symptoms and prevention of *Tuberculosis, pneumonia, influenza*	7 Hrs	7 marks	

References	➢ R.C. Dubey and D. K. Maheshwari (2023) A Text book of Microbiology, S. Chand,ISBN: 978-93-550-1186-2, Delhi. ➢ Madigan Michael T., Martinko John M., Bender Kelly S., Buckley Daniel H., and StahlDavid A. (2017) Brock Biology of Microorganisms, Microbiology, Fourteenth Edition,Pearson Education, ISBN:978-9332586864 ➢ R.M. Atlas and R. Bartha, Microbial Ecology (Fourth Edition), Pearson Education,ISBN:9788131713846 ➢ R. C. Dubey and P. Kumar (2022), Rhizosphere Engineering, Academic Press,Elsevier, USA, ISBN- 9780323899734 ➢ Poole, R. K. (2017). *Environmental Microbiology* (2nd ed.). Oxford University Press.

	➢ Oladele Ogunseitan (2004) Microbial Diversity: Form and Function in Prokaryotes, Wiley–Blackwell ➢ Bruce E. Rittmann, and Perry L. McCarty. (2001). Environmental Biotechnology: Principles and Applications. McGraw-Hill, ➢ Madigan, M., Bender K. S., Buckley D.H., Sattley W. M., and Stahl D.A.. (2017) Brock Biology of Microorganisms. 15th ed. New York: Pearson, . ➢ Sharma P. D. (2005) Environmental microbiology, Alpha Sciences international, ➢ Ian Papper and Charles Gerba (2014) Environmental microbiology, Elsevir Press. ➢ Patrick K. Jjemba (2004) Environmental microbiology: principles and applications, Science publisher, US
Model Questions	**Short Answer Questions** 1. Define ecology 2. Define methanotrophs 3. Enlist the types of microorganisms present in soil 4. Define humus 5. Define biogeochemical cycle 6. Define plankton 7. Define coagulation 8. What is break point chlorination? 9. Enlist symptoms of cholera 10. Enlist the preventive measures of typhoid 11. Enlist the preventive measures of Hepatitis 12. Write the symptoms of Tuberculosis 13. Enlist the symptoms of Pneumonia 14. Define mutualism 15. Define symbiosis 16. Define extremophiles 17. Define synergism 18. Define eutrophication 19. What are the different types of microorganisms in air? **Long Answer Questions** 1. Illustrate the types of positive association with suitable example 2. Describe the adaptation in extremophiles

	3. Define humus and explain formation of humus with its function 4. Explain the outline of nitrogen cycle 5. Describe the outline of carbon cycle 6. How will you control plankton problem? 7. Enlist the methods of chlorination and explain break point chlorination 8. Explain the symptoms and preventive measures of cholera 9. How will you control the microbial pollution in air? 10. Explain solid impingement devices **Multiple choice questions** 1 which of the following is the type of endosymbiosis a) Cooperation b) Commensalisms c) Mutualism d) Predation 9 which device is used for enumeration of bacteria in air a) Lemon Sampler b) Andersons air sampler c) both a and b d) None of these 10 Bacteria can fix the nitrogen *a) Pseudomonas* b) *Staphylococcus* c) *Rhizobium* d) *Lactobacillus* 11 the organism found floating free in open water is known as a) Phytoplankton b) Plankton c) Zooplankton d) Ultra plankton

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		20 Marks

127231 Theory 9 (Major): Biochemistry & Metabolism							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127231	Biochemistry & Metabolism	2	30	2 Hrs	30(Ext) + 20(Int)

Course Objectives

- To understand the structure, classification, and biological functions of carbohydrates, lipids, amino acids, proteins, nucleic acids, and vitamins.
- To explain the role of biomolecules in cellular metabolism and maintenance of life processes.
- To study the EMP pathway (glycolysis) and TCA cycle as major pathways of energy production.
- To understand the mechanism and significance of oxidative phosphorylation and the electron transport chain in ATP synthesis.
- To apply the concepts of biomolecules and metabolic pathways in biological and medical sciences.

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Explain the classification, structure, properties, and biological functions of carbohydrates and lipids
- Correlate the role of lipids and carbohydrates in energy production and membrane structure.
- Classify amino acids based on structure and nutritional importance.
- Explain the structure, types, and functions of DNA and RNA.
- Discuss the role of vitamins as coenzymes in biochemical reactions
- Describe major pathways of carbohydrate metabolism including glycolysis, TCA cycle, glycogenesis, glycogenolysis, and gluconeogenesis.
- Explain the mechanism and significance of Electron Transport Chain (ETC) and oxidative phosphorylation

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I **Carbohydrates and Lipids**	➢ Classification of carbohydrates ➢ Concept of Glycosidic linkages ➢ Structure of glucose, fructose, maltose, lactose,	8Hrs	8marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations.

	sucrose, starch, ➢ Classification of lipids, structure of triglyceride, compound lipids, derived lipids			**Hands-On Models**: use of model, Charts. **Problem-Solving Sessions**: Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit-II Amino acids and proteins	➢ Classification of amino acids ➢ Concept of Peptide bond ➢ Organizational levels of proteins ➢ Functions of protein	7 Hrs	7 marks	
Unit-III Nucleic acid and Vitamins	➢ Structure of nucleosides, nucleotides, DNA, RNA, and various forms of DNA ➢ Definition, Sources, classification of vitamins & their role in human health and metabolism ➢ Fat-soluble vitamins: A, D, E, K ➢ Water-soluble vitamins: B-complex and vitamin C	8 Hrs	8 marks	
Unit-IV Metabolism	➢ General strategies of metabolism. ➢ EMP pathway ➢ TCA cycle ➢ Oxidative phosphorylation and Electron transport chain	7 Hrs	7 marks	

References	➢ Principles of Biochemistry- G. Zubay, W.W. Parson, D.E.Vance. Wm.C.Brown Publishers ➢ Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th ➢ Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. edition W.H. Freeman & Company[Low price edition- for sale in India, Pakistan, Sri Lanka, Bangladesh, Nepal & Bhutan] ➢ Principles & techniques of Biochemistry &Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006 ➢ Laboratory manual in Biochemistry- J. Jayaraman ➢ Prescott, Hurley. Klein-Microbiology, 5th & 6thedition, International edition 2002 & 2006, McGraw Hill. ➢ Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole, Publishing Company, California. . ➢ Biochemistry – U. Satyanarayana, 6th Edition ➢ Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice Hall International Inc. ➢ Biochemistry – Lehninger – CBS Publishers. ➢ Biochemistry – Stryer – W. H. Freeman & Co. – New York. ➢ Fundamentals of Biochemistry. Jain, J. L..et al, S. Chand, India Limited, 2004.
Model Questions	**Short Answer Questions** 1. Define carbohydrates and mention their functions. 2. What are lipids? Write any two biological roles of lipids. 3. What are proteins? Mention their classification. 4. What is the EMP pathway? Mention its end products. 5. Write a short note on glycolysis. 6. What is the TCA cycle? State its significance. 7. Name the important enzymes involved in the TCA cycle. 8. Explain the electron transport chain briefly. 9. Mention the components of the electron transport chain. **Long Answer Questions** 1. Explain the structure, classification, and functions of carbohydrates and lipids in living organisms 2. Explain the structure, types, and functions of nucleic acids and vitamins.

	3. Describe the EMP pathway (glycolysis) in detail with reactions and significance. 4. Explain the TCA cycle with a neat diagram and discuss its importance in energy metabolism. 5. Describe oxidative phosphorylation and explain the role of the electron transport chain in ATP production. **Multiple choice questions** 1. The main function of carbohydrates is: a)Hormone production b)Energy supply c) Oxygen transport d) Insulation 2. The EMP Pathway is also called as a)Krebs cycle b) Glycolysis c) Calvin cycle d) Urea cycle 3. The first product formed in the TCA cycle is: a) Citrate b) Pyruvate c)Lactate d) Succinate 4. ATP synthesis in oxidative phosphorylation is carried out by: a) DNA polymerase b) ATP synthase c) Hexokinase d) Pepsin 5. Which molecule acts as the final electron acceptor in the electron transport chain? a) Carbon dioxide b)Oxygen c)Nitrogen d) Water

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		20 Marks

127232 Theory 10 (Major): Fundamentals of Industrial Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127232	Fundamentals of Industrial Microbiology	2	30	2 Hrs	30(Ext) + 20(Int)

Course Objectives

- To Understand the theoretical foundations and operations of bioreactors (fermenter),
- To learn strategies for the isolation and screening of production strain.
- To impart knowledge about various microorganism use in fermentation process.
- To impart knowledge about various primary and secondary metabolites.
- To make the student understand different production of fermented products.

Course Outcomes

Upon completion of this course successfully, students would be able to

- Illustrate appropriate use of fermenter for fermentation process.
- Apply the knowledge for isolation of production strains.
- Select appropriate method of fermentation for fermented product
- Able to differentiate the primary and secondary metabolites in fermentation process.

Unit System	Contents	Workload allotted	Weight age of Marks Allotted	Incorporation of Pedagogies
Unit 1 Industrial Microbiology in General	➢ Definition and scope of Industrial Microbiology ➢ Design of Fermenter and types of fermenter ➢ Concept of fermentation processes and its types ➢ Raw materials for industrial fermentation process	8Hrs	8marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model, Charts. **Problem-Solving Sessions**: Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video

Unit 2 **Role of microbes in Fermentation Industry**	➢ Concept of Production strain ➢ Primary and secondary screening for production strain ➢ Concept of primary and secondary metabolites in fermentation industry ➢ Importance of downstream processing in fermentation Industry	7 Hrs	7 marks	lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 **Industrial Production-I**	➢ Ethyl-alcohol: From molasses and Waste sulphite liquor. ➢ Beer ➢ Wine (Red and White) ➢ Acetone-Butanol from corn	8 Hrs	8 marks	
Unit 4 **Industrial Production-II**	➢ Vinegar- Fring's process ➢ Citric acid ➢ Production of Penicillin and semi-synthetic penicillin ➢ Amylase: Bacterial and fungal	7 Hrs	7 marks	

References	➢ Microbiology :Pelczar, Chan, Krieg.(TMH) ➢ Patel, A.H.: Industrial Microbiology, McMillan India. ➢ Pelczar, M.J., Chan, E.C.S. & Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.

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Powar,C.B.&Daginawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay
Prescott, L.M. et al. (2005 & 2007).Microbiology, McGraw Hill International Edition, USA.
Raj, A.E.; Karanth, N.G. Fermentation technology and bioreactor design. Food Science and Technology New York Marcel dekkar.2006.
Text Book of Microbiology : Dubey &Maheshwari (S.Chand, Publication)

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<tr><td>Model Questions</td><td>
Answer in one sentence

What is fermenter
Define fermentation
Define production strain
Define raw material

Short Answer Questions

Explain scope of industrial microbiology
Draw available diagram of fermenter
Differentiate between batch and continuous fermentation
Describe raw materials used for production media
Explain importance of downstream process

Long answer question

Describe screening procedure for isolation of production strain
Explain the concept of primary and secondary metabolites
Describe ethyl alcohol production from molasses
Describe wine production
How fungal Amylase is produced.

Multiple choice questions
1. Submerged fermentations....
a) Batch fermentation b) Continuous fermentation
c) Both a and b d) None of these
2. Industrial microbiology mainly depends on the phenomenon …
a) Metabolism b)Fermentation
c) Vaccination d) Both a and b
3. Part of fermenter is used for mixing of medium and inoculum
a) Impeller b) Headspace
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</table>

	c) Antifoam d) Cooling Jacket 4. Overheating of fermenter during fermentation is controlled by... a) Cooling jacket b) Cool air c) Steam d) None of these

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		**20 Marks**

127233 Practical 10 (Major): Biochemistry & Environmental Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127233	Biochemistry & Environmental Microbiology	2	60	2 Hrs	25(Ext) + 25(Int)

Course Objectives

- Prepare solutions, reagents, and buffers required for biochemical experiments.
- Demonstrate qualitative estimation methods used in biochemistry laboratories.
- To analyze soil quality
- Isolation of soil, air and water microbial flora

Course Outcomes:

- Upon completion of this course successfully, students would be able to
- Demonstrate knowledge of the structure, function, and biochemical importance of major biomolecules
- Perform qualitative biochemical experiments using standard laboratory procedures.
- Understand soil profile analysis to know the quality of soil
- Isolate microorganisms from soil, air and water

Sr. No.	Contents of Practical
1	Preparation of normal and molar solutions.
2	Preparation of buffer solutions (phosphate, carbonate, acetate and citrate buffer)
3	Qualitative detection of carbohydrates.
4	Qualitative detection of Protein.
5	Qualitative detection of Lipids
6	Isolation of Symbiotic and Non-Symbiotic Nitrogen fixing microorganism from soil (Rhizobium, Azotobacter)
7	Analysis of soil – pH, moisture content, water holding capacity, percolation, capillary action.
8	Isolation of anaerobic bacteria from soil.
9	Isolation of Different types of microorganisms present in air
10	Microbial analysis of water by Standard plate count method

Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning

	➢ Collaborative Learning: Group-based activities, post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. ➢ Principles & techniques of Biochemistry &Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006 ➢ Laboratory manual in Biochemistry- J. Jayaraman ➢ Biochemistry – Stryer – W. H. Freeman & Co. – New York. ➢ Fundamentals of Biochemistry. Jain, J. L..et al, S. Chand, India Limited, 2004 ➢ Microbiology :Pelczar, Chan, Krieg.(TMH) ➢ **Environmental Microbiology (3rd Edition)** by Ian L. Pepper, Charles P. Gerba, and Terry J. Gentry. ➢ **Manual of Environmental Microbiology (4th Edition)** edited by Marylynn V. Yates, Carl P. Higgins, and Laura S. Smeaton.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 marks	**Total**	25 marks

127234 Theory 1 (DSE1-Major): Fermentation Technology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127234	Fermentation Technology	2	30	2Hrs	30(Ext) + 20(Int)

Course Objectives

- To impart knowledge about different parameters of fermentation process.
- To understand how to scale up processes from laboratory settings to industry.
- T to explore the use of microorganisms for large-scale, sustainable manufacturing.
- To make the students understand the microbial production.
- To make the student understand different methods use in Pharmaceutical industry.

Course Outcomes:

- Upon completion of this course successfully, students would be able to
- Illustrate the different parameters of fermentation process.
- Apply the knowledge for scale up processes from laboratory to industry.
- Select appropriate method for microbial production.
- Illustrate the different methods use in pharmaceutical industry.

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 Fermentation technology- I	➢ Monitoring of fermentation process. ➢ Types of Antifoam agents ➢ Strain development strategies. ➢ Inoculum development	8Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model, Charts. **Problem-Solving Sessions**: Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the
Unit 2: **Fermentation technology-II**	➢ Scale up of fermentation process. ➢ Sterilization of fermenter, media and Air ➢ Downstream processing i. Removal of in-soluble ii. Product Isolation	7 Hrs	7 marks	

	iii. Product Purification iv. Labeling and storage condition of product			topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 Production technology	➢ Protease: bacterial & fungal ➢ Vitamin B12 ➢ Single cell protein from algae (Spirulina) ➢ Amino acids- Glutamic Acid	8 Hrs	8 marks	
Unit 4 Pharmaceutical Microbiology	➢ Good manufacturing practices ➢ Bioassay of growth inhibiting substances- Antibiotic ➢ Quality control tests for pharmaceutical products: ➢ Sterility testing ➢ Microbial Limit Test (MLT)	7 Hrs	7 marks	

References	➢ McNeil, B.; Harvey, L. eds. Practical fermentation technology. John Wiley & Sons. 2008. ➢ Microbiology :Pelczar, Chan, Krieg.(TMH) ➢ Patel, A.H.: Industrial Microbiology, McMillan India. ➢ Powar,C.B.&Daginawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay ➢ Prescott, L.M. et al. (2005 & 2007).Microbiology, McGraw Hill International Edition, USA. ➢ Raj, A.E.; Karanth, N.G. Fermentation technology and bioreactor design. Food Science and Technology New York Marcel dekkar.2006. ➢ Text Book of Microbiology : Dubey &Maheshwari (S.Chand, Publication)

Model Questions	**Answer in one sentence** 1. Define antifoam agent 2. Define inoculum 3. What is bioassay 4. Long form of MLT **Short Answer Questions** **1.** Explain the strain development strategies 2. Describe in occullum development. 3. Explain the scale up of fermentation process 4. Describe the industrial sterilization 5. Explain the good manufacturing practices **Long Answer Questions** 1. Describe the step involved in monetary of fermentation process 2. Explain the downstream process 3. Explain the production of protease 4. Explain the production of single cell protein from spirulina 5. Describe the bio assay of growth inhibiting substances **Multiple choice questions** 1. Antifoam agent is... a) Silicon compounds b) Corn oil c) Soybean oil d) All of these 2. Transfer of process from lab to industry is... a) Fermentation scale up b) Production strategy c) Fermentation planning d) All of these 3. Downstream processing is … a) Product purification b) Product isolation c) Product storage d) All of these 4. Vitamin B12 is one of the important vitamins of... a) A complex b) B complex c) C complex d) D complex

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 base on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 test</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 base on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
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127235 Lab Practical (DSE1:Major): Fermentation Technology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127235	Fermentation Technology	2	60	2 Hrs	25(Ext) + 25(Int)

Course Objectives	➢ To understand the use and operation of different parts of fermenter. ➢ To train the students different methods use in Pharmaceutical microbiology. ➢ To impart training of different microbial production.	
Course outcomes	Upon completion of this course successfully, students would be able to ➢ Use techniques for microbial production. ➢ Apply the knowledge offermentation to produce different product ➢ Select and use appropriate strain for microbial production.	
Sr. No.	**Content of Practical (List of Laboratory Experiments)**	**Incorporation of Pedagogies**
1	Study the different parts of fermenter.	**Experiential Learning:** Hands-on experimentation using model kits facilitates understanding and enhances practical skills. **Collaborative Learning:** Group-based activities. Maintaining laboratory records, observations and Post-experiment discussions encourage critical evaluation and correlation of experimental results with theoretical principles. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic.
2	Citric acid production by *Aspergillus niger*	
3	Protease production by solid state fermentation.	
4	Production of wine from grapes in the laboratory	
	Downstream process of fermentation	
5	Separation of amino acids by TLC/Paper Chromatography	
6	Estimation of amylase activity in human saliva/ diastase	
7	Sterility testing of pharmaceutical products- Tablets, eye and ear drops.	

References	➢ McNeil, B.; Harvey, L. eds. Practical fermentation technology. John Wiley & Sons. 2008. ➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by S. Chand ➢ A Text book of Practical microbiology by Sadar and Pande, Ed. Rachana Pachori

	(Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I & II: Power &Daginawala. (Himalaya Publication) ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ Raj, A.E.; Karanth, N.G. Fermentation technology and bioreactor design. Food Science and Technology New York Marcel dekkar.2006

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

127236 Theory 2 (DSE 2-Major): Agriculture Biotechnology, Bioinstrumentation and Biostatistics							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127236	Agriculture Biotechnology, Bioinstrumentation and Biostatistics	2	30	2 Hrs	30(Ext) + 20(Int)

Course Objectives

- To impart knowledge about and skill about crop improvement
- To make the students understand the various types of microbes used in agriculture biotechnology
- To impart knowledge about bioinstrumentation and its applications
- To make the student understand biostatistics in maintaining biological data

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Learn concept of Agriculture Biotechnology.
- understand the concepts of Bio fertilizer, Bio insecticides, Gene manipulations
- apply their knowledge regarding biological data handling by using biostatics
- understand the applications of bioinstrumentation to analyse biological data

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 Introduction to Agriculture Biotechnology	➢ Sustainable Agricultural practices ➢ Beneficial Microbes in Agriculture: Bacteria, Fungi and Cyanobacteria ➢ Role of microbes in soil fertility and crop production, biological nitrogen fixation, phosphate and zinc solubilisation ➢ Preparation of compost from agriculture waste and kitchen waste	8Hrs	8marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of model, Charts. **Problem-Solving Sessions**: Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and

Unit 2 Crop Improvement	➢ Plant Genetic Engineering – crop improvement, herbicide resistance, insect resistance ➢ Genetic modification in Agriculture – transgenic plants, genetically modified foods. ➢ Concept, methods and role of Tissue culture in agriculture ➢ Applications of Agriculture Biotechnology	7 Hrs	7 marks	simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**
Unit 3 Bioinstrumentation	➢ Chromatography: Definition, applications and example (Paper Chromatography) ➢ Electrophoresis: Definition, applications and example (Gel Electrophoresis) ➢ Spectroscopy: Definition, application and example (U.V Spectroscopy) ➢ Isotope tracer techniques: Definition and its applications	8 Hrs	8 marks	
Unit 4 Biostatistics	➢ Introduction, definition, various terms used in Statistics and Scope/application of statistics ➢ Data collection, types and its presentation ➢ Measures of central tendency: Arithmetic Mean, median, mode ➢ Measures of dispersion: Mean deviation and Standard deviation	7 Hrs	7 marks	

References	➢ Microbiology. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R, 2009, McGraw Hill Publishers ➢ Microbiology. Prescott, L.M, Harley, J.P. and Klein, D.A., 2008, McGraw Hill PublishingLtd ➢ Brock Biology of Microorganisms. Madigan, M., Martinko, J.M. and Parker, J. 2009, . ➢ Prentice Hall of India Pvt. Ltd. ➢ Soil Microbiology: Subba Rao, N.S.(4th Ed.) 2014. Oxford & IBH Publishing Co.Pvt. Ltd. ➢ Naveen Kango, 2010, Text Book of Microbiology , I.K. International Publishing House Pvt.Ltd ➢ G. Rangaswami, D.J. Bagyaraj , 2016 , Agricultural Microbiology, PHI Learning Pvt.Ltd ➢ Shiva Aithal, NikhileshKulkarni , 2010, Modern Approaches Soil Agriculture &Environmental Microbiology , Himalaya Publishing House ➢ AhindraNag , 2008 , Text Book Of Agricultural Biotechnology, PHI Learning ➢ Alexander N. Glazer, Hiroshi Nikaido , 2008 , Microbial Biotechnology Fundamentals of Applied Microbiology , Cambridge University Press ➢ Biophysical chemistry Principles and Techniques by Upadhyay ,Upadhyay, Nath Himalaya Publishing House ISO 9001: 2015 CERTIFIED ➢ Biostatistics - A Foundation for analysis in Health Sciences - W.D.Daniels, John wiley and Sons. ➢ 113. Basic Statistics - C, Dunn ➢ Fundamentals Biostatistics- SadguruPrakash, Emkay Publication, New Delhi.
Model Questions	**Short Answer Questions** 1. Enlist beneficial microorganisms in agriculture 2. Define compost 3. What is transgenic plant? 4. Define tissue culture 5. Write any two applications of agriculture biotechnology 6. Define chromatography 7. Define electrophoresis 8. Define spectroscopy 9. Write any two applications of isotope tracer technique

10. Define mean / mode / median
11. Write any two applications of biostatics

Long Answer Questions

1. Explain in detail beneficial microorganisms in agriculture
2. Discuss the process of compost preparation
3. Explain the role of phosphate and zinc solubilizing microorganisms in soil fertility
4. Define and write the applications of chromatography
5. Define and write the applications of electrophoresis
6. Define and write the applications of spectroscopy
7. Define and write the applications of isotopic tracer technique
8. Explain in detail measures of dispersion
9. Write the applications of biostatics

Multiple choice questions

1 Phosphate-solubilizing microbe (PSMs) convert insoluble soil phosphorus into forms like $H_2PO_4^-$ that plants can absorb. What is their primary mechanism of action?

a) The physical crushing of rock minerals using microscopic mechanical pressure
b) The direct absorption and assimilation of phosphorus into fungal spores for plant harvest
c) The production of high levels of heat to melt chemical complexes
d) The secretion of organic acids that lower localized soil pH and chelate bound cations

2 Zinc-solubilizing bacteria (ZSB), such as certain strains of Pseudomonas, are particularly critical in which type of soil condition where zinc is commonly immobilized?

a) Alkaline or calcareous soils
b) Waterlogged organic mucks
c) Highly acidic soils
d) Sterile hydroponic systems

3 Which of the following genes are commonly introduced into crops like Bt cotton to provide resistance against lepidopteran insects?

a) cry genes b) bar genes c) vir genes d) epsps genes

4 Which plant tissue culture technique is most effectively deployed to produce virus-free elite lines from an infected mother plant?

a) Another culture b) Protoplast fusion c) Callus culture d) Meristem culture

5 How does electrophoresis separate biomolecules like DNA or proteins?

	a) By moving them through a medium under the influence of an electric field based on charge and size. b) By spinning them at ultra-high speeds in a centrifuge based on density. c) By evaporating the molecules based on their boiling points. d) By measuring how much light they scatter when in solution.

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		**20 Marks**

127237 Lab Practical (DSE 2: Major): Agriculture Biotechnology, Bioinstrumentation and Biostatistics							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127237	Agriculture Biotechnology, Bioinstrumentation and Biostatistics	2	60	2 Hrs	25(Ext) + 25(Int)

Course Objectives	➢ To train the students in isolation of soil microbial flora in laboratory ➢ To impart knowledge for preparing different bio fertilizers ➢ To educate the students about the handling and use of biomedical instruments ➢ To gain knowledge about the biological data handling and data calculation by using biostatics
Course outcomes	Upon completion of this course successfully, students would be able to ➢ Understand the basic concept of handling biological data in biostatics tools ➢ Prepare commercial level bio fertilizers ➢ Isolate microorganisms present in soil ➢ Understand the working, principal, and operation of various instruments used in chromatography, electrophoresis

Sr. No.	Content of Practical
1.	Development of Rhizobium Bio inoculant / Bio fertilizer
2.	Isolation of Azotobacter from soil and development of Azotobacter Bio inoculant /Bio fertilizer
3.	Preparation of compost from vegetable/leaf /fruit wastes
4.	Demonstration of effect of Bio fertilizer on plant growth using pot culture.
5.	Separation of amino acids from the sample by paper chromatography
6.	Preparation of agarose gel for electrophoresis
7.	Measurement of given data by mean, median and mode
8.	Calculate the mean deviation and standard deviation from given data
9.	Visit to functional greenhouse/ Composting Unit/Mushroom cultivation unit/ and report writing
Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning

	➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, Practical Microbiology (Revised edition) ➢ Harley, John P., and Lansing M. Prescott. (2002) Laboratory Exercises in Microbiology. McGraw-Hill, ➢ Dhingra, Odile D., and James B. Sinclair. (1995) Basic Plant Pathology Methods. CRC Press, ➢ Rangaswami, G., and D. J. Bagyaraj. (2004) Agricultural Microbiology. PHI Learning Pvt. Ltd., ➢ Subba Rao, N. S. (1993) Soil Microorganisms and Plant Growth. Oxford & IBH Publishing, ➢ Gupta, P. K. (2010) Practical Manual of Agricultural Microbiology. Agrobios (India), ➢ Reddy, S. M. (2015) Microbial Biotechnology in Agriculture and Aquaculture. ScientificPublishers ➢ Biophysical chemistry Principles and Techniques by Upadhyay ,Upadhyay, Nath Himalaya Publishing House ISO 9001: 2015 CERTIFIED ➢ Biostatistics - A Foundation for analysis in Health Sciences - W.D.Daniels, John wiley and Sons. ➢ 113. Basic Statistics - C, Dunn ➢ Fundamentals Biostatistics- SadguruPrakash, Emkay Publication, New Delhi.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	**25 Marks**	**Total**	**25 Marks**

127238 Theory 5 (Minor): Environmental Microbiology and Biomolecules							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127238	Environmental Microbiology and Biomolecules	2	30	2 Hrs	30(Ext) + 20(Int)

Course Objectives

- To impart knowledge about water purification system
- To make the students understand the role of soil microorganisms in maintaining biogeochemical cycles
- To understand the structure, classification, and biological functions of carbohydrates, lipids, amino acids, proteins, nucleic acids, and vitamins.
- To explain the role of biomolecules in cellular metabolism and maintenance of life processes.

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Illustrate different methods to treat water
- Apply the knowledge about soil microbial flora
- Explain the classification, structure, properties, and biological functions of carbohydrates and lipids
- Correlate the role of lipids and carbohydrates in energy production and membrane structure.
- Classify amino acids based on structure and nutritional importance.

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit 1 Soil Microbiology	➢ Microorganisms in soil and their significance ➢ Concept of rhizosphere and rhizoplane. ➢ Definition, formation, function and Microbiology of Humus ➢ Biogeochemical Cycle:	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**:

	outline of Nitrogen cycle, Carbon cycle, Sulphur cycle and Phosphorus cycle.			use of model, Charts. **Problem-Solving Sessions**: Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based**
Unit 2 Water Microbiology	➢ Planktons: Definition , types problems and control, Eutrophication and its control ➢ Treatment of water: Aeration, Coagulation, Flocculation, Sedimentation and filtration ➢ Methods of Chlorination: plain, super chlorination, ammonia chlorine treatment, Break point chlorination. ➢ Water borne diseases: Etiology, symptoms and prevention of Cholera, Typhoid, Hepatitis.	7 Hrs	7 marks	
Unit 3 Carbohydrates and Lipids	➢ Classification of carbohydrates ➢ Concept of Glycosidic linkages ➢ Structure of glucose, fructose, maltose, lactose, sucrose, starch, ➢ Classification of lipids, Structure of triglyceride, compound lipids, derived lipids	8 Hrs	8 marks	

Unit 4 Amino acids and Proteins	➢ Classification of amino acids, ➢ Concept of Peptide bond ➢ Organizational levels of proteins, ➢ Functions of protein	7 Hrs	7 marks	**Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable.**

References

- Microbiology: Pelczar, Chan, Krieg.(TMH)
- Text Book of Microbiology: Dubey &Maheshwari (S.Chand, Publication)
- Fundamental of Microbiology: Frobisher
- General Microbiology Vol. I & II: Power &Daginawala. (Himalaya Publication)
- Fundamentals Principles of: A.J. Salle. bacteriology
- Elementary Microbiology: Modi (Akta Prakashan) Vol. I & II
- Microbiology an introduction (Ninth edition) By-Tortora,Funke,Case Published by-
- Dorling Kindersley (India) Pvt Ltd.
- Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand
- Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications
- Principles of Biochemistry- G. Zubay, W.W. Parson, D.E.Vance. Wm.C.Brown Publishers
- Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th
- Lehninger- Principles of Biochemistry- David Nelson, Michael Cox.

edition W.H. Freeman &Company[Low price edition- for sale in India, Pakistan, Sri Lanka, Bangladesh, Nepal & Bhutan]

- Principles & techniques of Biochemistry &Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006
- Laboratory manual in Biochemistry- J. Jayaraman
- Prescott, Hurley. Klein-Microbiology, 5th & 6thedition, International edition 2002 & 2006, McGraw Hill.
- Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole,

	Publishing Company, California. ➢ Biochemistry – U. Satyanarayana, 6th Edition
Model Questions	**Short Answer Questions** 1. Enlist the types of microorganisms present in soil 2. Define humus 3. Define biogeochemical cycle 4. Define plankton 5. Define coagulation 6. What is break point chlorination? 7. Enlist the preventive measures of typhoid 8. Enlist the preventive measures of Hepatitis 9. Write the symptoms of Tuberculosis 10. Enlist the symptoms of Pneumonia 11. Define carbohydrates and mention their functions. 12. What are lipids? Write any two biological roles of lipids. 13. What are proteins? Mention their classification. **Long Answer Questions** 1 Define humus and explain formation of humus with its function 2 Explain the outline of nitrogen cycle 3 Describe the outline of carbon cycle 4 How will you control plankton problem? 5 Enlist the methods of chlorination and explain break point chlorination 6 Explain the symptoms and preventive measures of cholera 7 Explain the structure, classification, and functions of carbohydrates and lipids in living organisms 8 Explain classification and functions of protein **Multiple choice questions** 1 Which of the following is the type of endosymbiosis? b) Cooperation b) Commensalisms c) Mutualism d) Predation 2 which device is used for enumeration of bacteria in air b) Lemon Sampler b) Andersons air sampler c) both a and b d) None of these 3 Bacteria can fix the nitrogen ***a)****Pseudomonas* b) *Staphylococcus* c) *Rhizobium* d) *Lactobacillus*

	4 The main function of carbohydrates is: a) Hormone production b)Energy supply c) Oxygen transport d) Insulation

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		**20 Marks**

127239 Lab Practical 5 (Minor): Environmental Microbiology and Biomolecules							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127239	Environmental Microbiology and Biomolecules	2	60	2 Hrs	25(Ext) + 25(Int)

Course Objectives	➢ To analyze soil quality ➢ Isolation of soil, air and water microbial flora ➢ Prepare solutions, reagents, and buffers required for biochemical experiments. ➢ Demonstrate qualitative estimation methods used in biochemistry laboratories.
Course outcomes	Upon completion of this course successfully, students would be able to ➢ Understand soil profile analysis to know the quality of soil ➢ Isolate microorganisms from soil, air and water ➢ Demonstrate knowledge of the structure, function, and biochemical importance of major biomolecules ➢ Perform qualitative biochemical experiments using standard laboratory procedures.

Sr. No.	Content of Practical
1	Isolation of Symbiotic and Non Symbiotic Nitrogen fixing microorganism from soil (Rhizobium, Azotobacter)
2	Analysis of soil – pH, moisture content, water holding capacity, percolation, capillary action.
3	Isolation of anaerobic bacteria from soil.
4	Isolation of Different types of microorganisms present in air
5	Microbial analysis of water by Standard plate count method
6	Preparation of normal and molar solutions.
7	Preparation of buffer solutions (phosphate, carbonate, acetate and citrate buffer)
8	Qualitative detection of carbohydrates.
9	Qualitative detection of Protein.
10	Qualitative detection of Lipids

Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning ➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Environmental Microbiology (3rd Edition) by Ian L. Pepper, Charles P. Gerba, and Terry J. Gentry. ➢ Manual of Environmental Microbiology (4th Edition) edited by Marylynn V. Yates, Carl P. Higgins, and Laura S. Smeaton. ➢ Principles & techniques of Biochemistry &Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006 ➢ Laboratory manual in Biochemistry- J. Jayaraman ➢ Biochemistry – Stryer – W. H. Freeman & Co. – New York. ➢ Fundamentals of Biochemistry. Jain, J. L..et al, S. Chand, India Limited, 2004 ➢ Microbiology : Pelczar, Chan, Krieg.(TMH)

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	**25 Marks**	**Total**	**25 Marks**

127240 VSC- Lab Practical 11: Water Analysis for Environmental monitoring							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127240	Water Analysis for Environmental monitoring	2	60	2 Hrs	50 (Int)

Course Objectives	➢ To train the students in analysis of physical and chemical parameters of water ➢ To impart training skill in isolation of pathogenic microorganisms in water ➢ To educate the students about applying techniques for water analysis
Course Outcomes	Upon completion of this course successfully, students would be able to ➢ Use techniques of water analysis for environmental monitoring ➢ Use isolation techniques of pathogenic microorganisms in water ➢ Make use of water analysis techniques on commercial level
Sr. No.	**Content of Practical**
1.	To determine physical parameters of water by: colour, odour, pH, turbidity, and Total Dissolved solids (TDS)
2.	To determine total hardness of water sample
3.	To determine chlorine demand and residual chlorine of water sample
4.	To determine chloride ions in water sample
5.	To determine chemical/Biological oxygen demand of water sample
6.	To analyze aerobic microbial count/ Standard plate count of water sample
7.	To determine the presence of faecal coliform/ Streptococci in water sample
8.	To visit the water analysis laboratory or local municipal corporation water supply plant.
Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning ➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	1. Microbiology, A laboratory manual byjames D. cappuccino andNatalie Sherman Addison Wesley publication, 2. Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari

	Published by-S.Chand 3. A Text book of Practical microbiology by Sadar and pande, Ed.RachanaPachori(Sharma), Dnyanpath Publication. 4. Practical Microbiology(Revised edition R.C.Dubey and D.K.Maheshwari Published by-S.Chand 5. Textbook of Microbiology(Fourth edition) Prof. C P Baveja Published by Arya publications

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

127241 SEC- Lab Practical 12: Microbial Fermentation							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127241	Microbial Fermentation	2	60	2 Hrs	50 (Int)

Course Objectives	➢ To train the students in methods of screening microorganisms. ➢ To impart training of isolation of production strain using appropriate methods. ➢ To educate the students about applying techniques for testing of product.
Course outcomes	Upon completion of this course successfully, students would be able to ➢ Use various techniques for screening microorganisms. ➢ Know the proper method for isolation of production strains. ➢ Make use of methods for testing of product.
Sr. No.	**Content of Practical**
1.	Design the layout of fermenter for anaerobic fermentation process.
2.	Screening of antibiotic producing microbial strain from soil.
3.	Screening of Amylase Producing microbes for industrial production
4.	Production of alcohol from jaggery.
5.	Production of wine from different fruits
6.	Physicochemical Testing and Sensory Evaluation of fermented products (Alcohol & Wine)
7.	Study the Microbial Limit Test for industrial products (Food & pharmaceutical product)
8.	Prepare the report of Market survey for fermented product demand (any two products)
9.	Collect the information of fermentation industry.

Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning ➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic

References	➢ McNeil, B.; Harvey, L. eds. Practical fermentation technology. John Wiley & Sons. 2008. ➢ Microbiology, A laboratory manual by James D. Cappuccino and Natalie Sherman Addison Wesley publication, ➢ Practical Microbiology(Revised edition R.C. Dubey and D.K. Maheshwari Published by S. Chand ➢ A Text book of Practical microbiology by Sadar and Pande, Ed. Rachana Pachori (Sharma), Dnyanpath Publication. ➢ General Microbiology Vol. I & II: Pawar & Daginawala. (Himalaya Publication) ➢ Practical Microbiology (Revised edition R.C. Dubey and D.K. Maheshwari Published by-S. Chand ➢ Raj, A.E.; Karanth, N.G. Fermentation technology and bioreactor design. Food Science and Technology New York Marcel dekkar.2006

Internal Evaluation for SEC	
Attendance	10 Marks
Practical performance in Lab.	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

127242: Course Category: Field Project (FP)/Community Engagement and Service (CES) of Microbiology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	127242	FP/ CEP in Microbiology	2	60	--	50 (Int)

Course Objectives	The intended objectives are: • To provide practical, real-world experience, in their field of study, allowing them to apply theoretical knowledge to real-world situations or address Real-World Problems. • To enhance research, interpretation and analytical skills, strengthening their critical thinking and problem-solving abilities. • To foster engagement with specific microbiology related issues concerned with society, environment or agriculture etc. • To Improve Collaboration, Communication among students, facilitate knowledge transfer from lab to land and get self-inspiration for contribution to the society by applying the subject knowledge.
Course Outcomes	Upon successful completion of this course: • Students will be developed regarding practical and technical skills and a deeper understanding of their subject matter and how it applies to real-world situations. • They will learn to identify, analyse, and interpret complex problems using their knowledge and will develop research skills. • Students will gain insight into social issues and the role of various governmental and non-government organizations (NGO) for the welfare of people and explore new ideas and approaches. • They will learn to work effectively in teams and collaborate with others to achieve common goals and contributing to resolve community's problems & challenges related with the subject.
As per NEP 2020, students of B Sc. III of Semester V need to perform a Field Project (FP)/ Community Engagement and Service (CES) for TWO (2) credits i.e. 50 Marks. The guidelines/ SOP regarding the FP/CES are as follows: 1) The total time allocation for the student to carry out FP/CES is 60 hours.	

2) Students should participate in FP/CES under the supervision of faculty.
3) Assigning the FP/CES topics to individual students or groups of students (4to5 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
4) CES may include awareness programs, public talk/ lectures, workshops, blood testing camps, vaccination drives in collaboration, surveys etc.
5) Field project may be undertake to include survey/ laboratory work/ data analysis/ field work or in combination of these which involves practical application of knowledge and skills to address a specific problem or issue within microbiological context such as health, sustainable environment, agriculture etc.
6) For a SURVEY based FP/CES, related questionnaire (15 or more questions) should be prepared. The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
7) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc. The report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.) Submit the project report with the Guide's signature to the department.
8) Students should maintain the documentation and record properly which includes dairy, photographs, certificates, feedback of beneficiaries, news in local paper if any.
9) A CES report should be written individually in the standard format (2 Copies): Index, Introduction, details of activities, photographs, signature sheets of beneficiaries, feedback of beneficiaries, own feedback, summary /output, etc. It should be submitted with the Guide's signature to the department.
10) The oral /poster presentation for all the FP/CES should be arranged in the department. To evaluate the project, examiner should be appointed by HOD.
11) The total work for FP/CES including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).
12) Some Suggested Field-Based and Conservation-Oriented Activities:
    1. Environmental Sample Collection
    2. Water Quality Assessment
    3. Soil Microbiology Studies

	4. Industrial and Agricultural Visits 5. Public Health Field Visits 6. Microbial Biodiversity Documentation 7. Environmental Monitoring 8. Waste Management 9. Bioremediation Studies 10. Sustainable Agriculture 11.Conservation Awareness Programs
References	1. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 2. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program 3. https://afribary.com/blog/1785/recent-microbiology-research-topics-for-undergraduates 4. https://www.iprojectmaster.com/final-year-projects-materials/micro-biology
Model Que:	**Not Applicable**

Distribution of Marks and the scheme of FP/CES Evaluation as follow:

Sr. No	Evaluation base on	Marks
1	Student performance	20
2	FP/CES Report	20
3	Presentation (PPT or Poster)	10
	Total	**50**

Tittle: Non-Credit Compulsory Course for SEM-V

Name of Course – "Foundation of Artificial Intelligence"

Introduction:

The National Education Policy (NEP) 2020 emphasizes the integration of Artificial Intelligence (AI) across all undergraduate levels and disciplines to foster digital literacy and problem-solving skills. 'It can enhance the employability of the youth and prepare professionals in cutting-edge areas.'(pg. 46, R.D Kulkarni Report)

The Foundations of Artificial Intelligence course offers an overview of the key concepts, structures, applications, and ethical aspects of AI. It helps learners understand how intelligent systems work and shape modern life. The course covers AI's definition, evolution, types, and practical uses, along with its basic architectures like rule-based systems, machine learning, and neural networks. Learners will explore AI's role in education, healthcare, and commerce while reflecting on ethical and social concerns such as privacy, bias, and automation. In line with NEP 2020, it fosters digital literacy and responsible AI awareness for all disciplines.

A) Objective

i) Introduce all undergraduate students of all the faculties to the basic concepts, uses, and importance of AI.

ii) Enable learners to understand AI's principles, applications, limitations, and effectively use AI tools.

iii) Encourage students to recognize AI's role in enhancing life and engage with its social and ethical implications.

B) Outcomes

i) Understand the fundamental concepts, types, and evolution of Artificial Intelligence.

ii) Apply basic AI techniques and tools to real-world problems across different domains.

iv) Evaluate the social, ethical, and professional implications of AI in everyday life.

C) Implementation of Syllabus, Scheme of Examination and Teaching

1. Curriculum, Teaching and Examination Scheme Given in Appendix A
2. This course given in Appendix A shall be compulsory course in **fifth semester** of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati.

3. Medium of instruction, paper setting and writing of Answer paper shall be in English, Marathi and Hindi.

4. Question paper shall be set and valuated by the College/ Department.

5. Duration of external examination shall be of 2 hours and paper shall be of 30 marks.

6. Internal 20 marks shall be distributed, 5 to attendance, 15 marks to assignment/class test/viva voce/presentation.

7. Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions.

8.It shall be obligatory on part of the college/department to conduct examination on prescribed date by the university and submit the candidate wise information as follows on university portal on due date after valuation answer books.

- Grade A -- mark secured 30 to 50,
- Grade B -- 25 to 29,
- Grade C- 20 to 24,
- FAIL 19 and below

9. The final Grade shall be determined by the combined performance in internal and external assessments. A student must secure a minimum of 30% in the internal assessment, 30% in the external assessment, and at least 40% overall to pass. Failure to meet any of these criteria will result in a grade of "Fail."

10. In case of failure, student needs to appeared in backlog examination by paying prescribed fees.

11. Valuated answer book shall be kept in college custody for one academic year and random verification may be done by the University if required.

12. Result of final year of respective degree shall not be declared of an examination unless secured any of the grades out of A to C in Foundation of Artificial intelligence.

13. Grade secured by an examinee in examination of said course shall be shown on fifth and last semester marksheet.

14. The candidates shall have to pay Rs 150 /- in 5th semester to the college to meet out the expenses by the college on teaching of course, question paper setting and printing, paper valuation, providing answer sheet, and filling grade on University portal. In case of failure student need to pay Rs 20 /- for conduction of examination. There shall not have any facility of revaluation of answer book.

15.For teaching of the subject person having PG degree in any faculty with second class shall be considered eligible, provided priority shall be given to Ph.D., NET, SET, regular

teacher.

16**.** Format of question paper

Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions with internal choice.

1a) Long or short answer questions based on unit number 1 having 8 marks

OR

1b) Long or short answer questions based on unit number 1 having 8 marks

2a) Long or short answer questions based on unit number 2 having 7 marks

OR

2b) Long or short answer questions based on unit number 2 having 7 marks

3a) Long or short answer questions based on unit number 3 having 8 marks

OR

3b) Long or short answer questions based on unit number 3 having 7 marks

4a) Long or short answer questions based on unit number 4 having 8 marks

OR

4b) Long or short answer questions based on unit number 4 having 8 marks

Program:				**Semester:**	**V**	
Course:	**Foundation of Artificial Intelligence**			**Code:**		
Teaching Scheme				**Evaluation Scheme**		
Level	**Lecture**	**Hours**	**Credit**	**Internal**	**External**	**Total**
5.5	2	2	2	20	30	50
Methods of Internal Assessment: 15 Marks to Class Tests,/Assignments/Viva voce/Presentation&5 Mark to Attendance						
Course Objectives: To introduce AI concepts in a simple, real-life way with focus on understanding applications, ethics, and future opportunities.						
Course Outcomes: After completion of the course, the students will be able to:						

CO	**Course Outcomes**	**BT Level**
CO-1	Explain the basic concepts, history, and types of AI with real-life examples.	L1 – Knowledge, L2 – Understanding
CO-2	Describe AI structures and architectures using simple real-world analogies.	L2 – Understanding, L3 – Application
CO-3	Identify and analyze applications of AI in the area of arts, commerce, humanities, and daily life.	L3 – Application, L4 – Analysis
CO-4	Evaluate ethical, social issues and predict future opportunities of AI in their own fields.	L4 – Analysis, L5 – Evaluation

Unit 1: Introduction to Artificial Intelligence (8 Hours)

Definition of AI: What is Intelligence? Natural vs. Artificial, Simple definition of AI; History & Evolution of AI: From early computers to modern AI; Types of AI: Narrow AI vs. General AI vs. Super AI; AI in Everyday Life: Google Maps, E-commerce suggestions, Chatbots, Social Media feeds; Key Components: Data, Algorithms, Computing Power

Unit 2: AI Structures, Architectures & Techniques (7 Hours)

Basic Structure of an AI System; AI Architectures (Simplified): Rule Based System, Machine Learning, Neural Networks; Key Concepts: Knowledge Representation (using symbols, facts), Search & Problem Solving (maze example, finding shortest route), Natural Language Understanding (Google Translate, chatbots)

Unit 3: Applications of AI in Society (7 Hours)

AI in Different Fields: Education(Personalized learning apps, plagiarism checkers), Healthcare(Disease prediction, medical chatbots), Commerce (Fraud detection in banking, stock market predictions, customer support), Daily Life(Smart home devices, language translation, travel assistants); AI & Decision Making: Hiring, Loan Approval, Court Decisions; Advantages of AI, Limitations of AI

Unit 4: Ethical, Social & Future Aspects of AI (8 Hours)

Ethical Concerns in AI: Privacy issues (CCTV, online data), Bias & Fairness (AI preferring certain groups), Job Displacement (automation replacing humans); Responsible AI: Transparency, Accountability, Human oversight; Future Trends in AI: Self-driving cars, AI in governance, creative industries; AI and You (Career Perspective): Opportunities in Digital Marketing, Content Creation, Business Analytics, HR Tech, Creative Industries (non-programming roles)

Textbook:

Melanie Mitchell – *Artificial Intelligence: A Guide for Thinking Humans* Reference Books:

1. Boden, Margaret A., *Artificial Intelligence*: A Very Short Introduction
2. Elaine Rich – *Artificial Intelligence* (3rd Edition)
3. Godbole, Achyut, *Artificial Intelligence* (आर्टिफिशियल इंटेिलजन्स), Bookganga Publication.
4. Kulkarni, Dr Anand, आर्टिफिशियल इंटेिलजन्सच्या वाटेवर, Sakal Media Pvt. Ltd.
5. Stuart Russell – *Human Compatible* (2019)
6. Thorpe, Josh, *AI for Students: Creative Hacks for Academic Success*, Promplty Books

Sant Gadge Baba Amravati University, Amravati

FACULTY: Science and Technology (2 credits-50 marks major-minor)

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years - Six Semesters Bachelor's Degree Programme)

THIRD YEAR: SEMESTER -VI

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major Microbiology 127	Theory- 11	127243	Molecular Biology
		Theory- 12	127244	Food & Dairy Microbiology
		Theory- 13	127245	Genetic Engineering
		Lab/ Practical-13	127246	Applied Microbiology
	Major Elective 127	Theory- 3 DSE 3	127247	Fundamentals of Enzymology
		Lab/ Practical- DSE 3	127248	Fundamentals of Enzymology
		OR		
		Theory- 4 DSE 4	127249	Microbial Biotechnology And Entrepreneurship
		Lab/ Practical- DSE 4	127250	Microbial Biotechnology And Entrepreneurship
b.	Minor 127	Theory- 6	127251	Molecular Biology &Genetic Engineering
		Lab/ Practical -6	127252	Molecular Biology &Genetic Engineering
g.	Generic/ OE	-	-	-
h.	VSC	Lab/ Practical 14	127253	Quality control for Food and Dairy Products
i.	VEC	-	-	-
j.	Internship/ Apprenticeship	OJT	127254	Internship /Apprenticeship/ OJT (On the Job Training)
	FP/CES	Project	-	-

Programme: B.Sc. (Microbiology)

Course : **B.Sc. III Semester VI**

127243 Theory 11 (Major): Molecular Biology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127243	Molecular Biology	2	30	2 Hrs	30 (Ext) + 20(Int)

Course Objectives

- Understand the fundamental concepts of gene multiplication
- Explain the molecular mechanisms involved in gene expression, including transcription and translation
- Describe the regulatory mechanisms controlling gene expression in prokaryotes
- Analyze different types of gene mutations and their effects on cellular functions and genetic disorders
- Understand the mechanisms and importance of bacterial recombination in genetic diversity and adaptation.

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Explain the concept and mechanisms of gene multiplication and gene amplification.
- The regulation of gene expression through operons, transcription factors
- Classify different types of gene mutations and their causes
- Mechanisms of bacterial recombination such as transformation, transduction, and conjugation.

Unit System	**Contents**	**Workload allotted**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I **Gene Multiplication**	➢ Concept of gene Definition of Gene, Muton, recon, cistron, gene within gene, split gene. ➢ Replication of DNA- Modes of replication, (Conservative, Semiconservative and Dispersive). Experiment of	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures**: Use of multimedia presentations, interactive slides, and animations. **Hands-On Models**: use of

	Meselson and Stahl to prove semiconservative mode of replication. Mechanism of replication with enzymes involved, models of replication: Knife and fork, rolling circle. ➢ DNA repair mechanisms- light and dark.			model, Charts. **Problem-Solving Sessions**: Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning**: Explore topics through questioning,
Unit-II **Gene Expression and Regulation**	➢ Concept of Genetic code ➢ Outline of Translation (Protein synthesis) ➢ Gene regulation Mechanisms – Lac Operon Trp Operon	7 Hrs	7 marks	
Unit-III **Gene Mutation**	➢ Mutation- Definition & types of mutations – Base pair substitution, frame-shift, point, missense, nonsense & silent mutations, ➢ Molecular basis of spontaneous (Tautomerism) and induced mutations - ➢ Chemical Mutagens e.g. Base analogues, Nitrous Oxide, Hydroxylamine, Acridine dyes, ➢ Physical mutagens e.g. X-rays, Gamma rays, U.V. light.	8 Hrs	8 marks	
Unit-IV **Genetic Recombination**	➢ Transformation: Experiment of Griffith. Avery, MacLeod and McCarty	7 Hrs	7 marks	

	experiment to prove Genetic Transformation. ➢ Transduction: Experiment of Zinder and Lederberg. General Outline of Types of Transduction: Generalized and Restricted, ➢ Conjugation: Experiment of Lederberg and Tatum, Experiment of Davis, Nature and function of F Plasmid. Hfr formation. Various Mating types.			investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. **Any other innovative pedagogy as applicable**

References	➢ Fundamental Bacterial Genetics by Nancy Trun and JenanineTrumphy (2003), Publisher: Blackwell Publishers. ➢ Genetics a conceptual approach (5th Ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company ➢ Genetics A Molecular Approach (2nd / 3rd Ed.) by Peter J Russell (2006) ➢ Modern Microbial Genetics (2nd Ed.) by Uldis N. Streips, Ronald Yasbin. Publisher: Wiley-Liss, Inc. ➢ Microbial Genetics by Maloy et.al. 1994. Jones and Bartlett Publishers. ➢ Molecular Genetics of Bacteria by J.W.Dale 1994 John Wiley and Sons. ➢ Gene XII by Lewin Oxford University press. 2017 ➢ Organization of Prokaryotic genome. 1999 by Robert L Charlebois, ASM Publications. ➢ Recombinant DNA by Watson J.D.
Model Questions	**Short Answer Questions** 1. Define gene multiplication. 2. Name the enzymes involved in transcription 3. What is the significance of the lac operon 4. Differentiate between spontaneous and induced mutations 5. What is frameshift mutation 6. What is transduction? 7. State the importance of bacterial recombination.

	Long Answer Questions 1. Explain the concept, mechanisms, and significance of gene multiplication. 2. Explain the mechanism of translation with suitable diagrams 3. Explain the lac operon model and its significance 4. Define mutation and classify different types of mutation 5. Discuss spontaneous and induced mutations with examples 6. Describe bacterial conjugation with suitable diagrams. 7. Explain transformation and its significance in bacterial genetics **Multiple choice questions** 1. Gene multiplication is also known as a) Gene deletion b) Gene amplification c) Gene mutation d) Gene inversion 2. The lac operon is an example of a) Repressible operon b) Inducible operon c) Structural gene d) Muton 3. Which molecule acts as an inducer in lac operon? a) Glucose b) Lactose c) Maltose d) Fructose 4. Insertion or deletion of nucleotides may cause a) Silent mutation b) Frameshift mutation c) Reverse mutation d) Point mutation 5. UV radiation acts as a a) Catalyst b) Mutagen c) Enzyme d) Repressor 6. Uptake of naked DNA from the environment by bacteria is known as a) Conjugation b) Transformation c) Transduction d) Translation

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
	Total	20 Marks

127244 Theory 12 (Major): Food and Dairy Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127244	Food and Dairy Microbiology	2	30	2Hrs	30 (Ext) + 20 (Int)

Course Objectives

- Understand the basic principles and scope of Food Microbiology and Dairy Microbiology.
- Identify important microorganisms associated with food and dairy products, including beneficial and spoilage microorganisms.
- Explain the role of microorganisms in food spoilage, food preservation, and food-borne diseases.
- Understand microbial fermentation processes involved in the production of dairy products such as curd, cheese, yogurt, and butter.
- Apply microbiological principles in maintaining food quality and preventing contamination.
- Develop scientific and analytical skills related to food safety, quality assurance, and dairy microbiology practices

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Aware of applications of microbes in food production
- Study the principles and preservation of foods using microbes
- The details of spoilage of food and the role of governing bodies in Maintaining standards of food
- Acquire knowledge regarding basics and importance of Dairy Microbiology
- Learn about various milk products &Acquire knowledge regarding methods for preservation of milk and dairy products

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I **Food Microbiology**	➢ Sources of contamination of fresh food and Indicators of food contamination as per WHO. ➢ Microbial spoilage of foods. ➢ Preservation of foods: - Low and high temperature, dehydration,	8 Hrs	8 marks	Chalk & Board Interactive Lectures: Use of multimedia presentations, interactive slides, and animations. Hands-On Models:

	high osmotic pressure, chemical preservation, radiations and canning. ➢ Food poisoning: Food infection and food intoxication.			use of model, Charts. Problem-Solving Sessions: Organize regular problem-solving sessions. Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic. Flip-Class: Assign readings or video lectures, assignment as homework and use class time for interactive discussions. Concept Maps: Ask students to create own concept maps that illustrate the relationships between different concepts. Inquiry-Based Learning: Explore topics through questioning, investigation, and research. Case-Based Learning: Analyze and discuss real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable
Unit-II Fermented Food	➢ Production of oriental food: Soya sauce, Tofu. ➢ Production of bread, Idli, fermented vegetable: Sauerkraut ➢ Microbial quality control of food ➢ Market opportunities for fermented food products	7 Hrs	7 marks	
Unit-III Dairy Microbiology	➢ Introduction to Dairy Microbiology and Composition of Milk ➢ Types and Grades of Milk ➢ Types of microorganisms in milk ➢ Sources of contamination of Milk	8 Hrs	8 marks	
Unit-IV Fermented Dairy Products & Preservation	➢ Production of ➢ Yogurt, Cheese and Milk Powder ➢ Methods of preservation: a) High Temperature: Pasteurization sterilization & Canning b) Low Temperature: Refrigeration & freezing, ➢ Market opportunities for fermented Dairy products	7 Hrs	7 marks	

References	➢ Food Microbiology by Frazier 5th ed ➢ Modern Food Microbiology by James Jay 6th ed ➢ Applied Dairy Microbiology by Martha & Steele ➢ Prescott, Hurley. Klein-Microbiology, 7 the edition, International edition, McGraw Hill. ➢ Pelczar M.J., Chan E.C.S and Krieg N.R., (2001)Microbiology, McGraw Hill Book Company, New York ➢ Hammer B.W and Babal (1948), Dairy Bacteriology, Prentice Hall Incorporated, London. 8. ➢ Food Microbiology, 7th Edn. Springer Publishers ➢ Food Microbiology: Fazier W.C. & West hoff D.C. Fermented Foods (Vol.7): Rose A.A. ➢ IndustrialMicrobiology: Prescott S.C. & Dunn C.G. ➢ IndustrialMicrobiology: A.H. Patel ➢ Microbial Technology: Pepller H.J. (Vol. I & II) ➢ Industrial Microbiology: Casida L.E. ➢ Principles of Fermentation: Stanbury, Peter F. &Technology Allan. Whitaker ➢ Outlines of Diary Bacteriology : Sukumar De 21 ➢ Modern Food Microbiology: Jay, Mames M. ➢ Principles of Industrial: Rhodes & Fletcher. Microbiology ➢ Industrial Fermentation: Under Kofler & Hick.Vol. I & II ➢ DairyMicrobiology: Foster Etal. ➢ Industrial Microbiology :Ros
Model Questions	**Short Answer Questions** 1. Define Food Microbiology. 2. What is Dairy Microbiology? 3. What is sterilization? 4. What are food-borne diseases? 5. Mention any two methods of food preservation 6. Name two dairy products produced by fermentation. 7. What is meant by shelf life of food? 8. Define starter culture.

	Long Answer Questions 1. Describe the role of microorganisms in food spoilage 2. Describe the role of microorganisms in cheese production. 3. Explain food-borne diseases and their prevention. 4. Explain spoilage of milk and milk products 5. Describe methods used for microbial examination of food. 6. Describe the microbial quality control of milk. **Multiple choice questions** 1. The common bacterium used in curd preparation is: a) E. coli b) Lactobacillus c) Salmonella d) Vibrio 2. Which method is commonly used to preserve milk? a) Fermentation b) Pasteurization c) Drying d) Salting 3. Yogurt is produced by: a) Fermentation b) Mutation c) Distillation d) Evaporation 4. Which microorganism is commonly used in bread making? a) *Aspergillus* b) *Yeast* c) *Salmonella* d) *Penicillium*

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
	Total	20 Marks

127245 Theory 13 (Major): Genetic Engineering							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127245	Genetic Engineering	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives

- To provide students the recent knowledge of recombinant DNA Technology and genetic engineering
- To impart knowledge on the concept of genetic engineering including the techniques, applications and limitations.
- To describe the process of cloning and expression of gene and other techniques in genetic engineering & Biotechnology
- Understand PCR assays and DNA manipulations techniques

Course Outcomes

Upon completion of this course successfully, students would be able to

- Describe the concept of recombinant DNA Technology and genetic engineering
- Apply the knowledge of different techniques used in Genetic Engineering
- Describe the process of cloning and expression of gene
- Perform PCR assays and DNA manipulation techniques

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I Tools of Genetic Engineering	➢ Introduction to basic technique of genetic engineering and Enzymes for splicing: Restriction endonucleases. ➢ Range of DNA manipulating enzymes: Nucleases, Ligases, Polymerases, DNA modifying enzymes, Topoisomerases. ➢ Vectors: Ideal characters and types: Plasmid pBR322, Cosmid and	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models:** use of model, Charts. **Problem-Solving Sessions:** Organize

	Bacteriophage(Lambda) ➢ Concept of competent cells			regular problem-solving sessions.
Unit-II **Techniques Of Genetic Engineering-I**	➢ Isolation of Genomic DNA from bacteria ➢ Analysis of DNA fragments size by agarose gel electrophoresis. ➢ Identification of transformed cell (e.g. Antibiotic resistance gene in Plasmid) ➢ Selection of clones: Direct (colony hybridization) and Indirect method (southern blotting).	7 Hrs	7 marks	**Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable
Unit-III **Techniques of genetic engineering-II**	➢ Host Microorganisms for Genetic Engineering ➢ (*E. coli, S. cerevisiae*) ➢ Definition, method and applications of gene mapping ➢ DNA sequencing by microarray and PCR. ➢ Construction of gene library	8 Hrs	8 marks	
Unit-IV **Applications and Biohazards of Genetic Engineering**	➢ **Health care biotechnology:** Recombinant Insulin, Recombinant Hepatitis vaccine, ➢ Gene therapy, DNA probes in diagnosis. ➢ **Environmental Biotechnology:** ➢ Genetically engineered microbes for pollution control. ➢ Biohazards and ethical issues of genetic engineering.	7 Hrs	7 marks	

References	➢ Principles of gene manipulation. 1994. Old & Primrose, Blackwell Scientific Publications ➢ Molecular Cloning. 3 volumes. Sambrose and Russell, 2000. CSH Press. ➢ Genetics A Molecular Approach (2nd / 3rd Ed.) by Peter J Russell (2006) ➢ Recombinant DNA by Watson J.D. ➢ Recombinant DNA:-James. D. Watson, John. Tooze, David.Kutz ➢ Introduction to Genetic Engineering: - Nicholas ➢ An Introduction to Genetic Analysis: - David Suzuki, Anthony. Griffths ➢ Biochemistry: - Lehninger ➢ General Microbiology. Vol 1& II. : - Pawar & Daginawala ➢ Genetic Engineering and its Applications -Joshi P. ➢ Gene Transfer and Expreesion a Laboratory Manual: - Michael Kriegler ➢ Concept in biotechnology: - D. Balasubramanium
Model Questions	**Short Answer Questions** 1. Define genetic Engineering 2. Describe Restriction endonucleases 3. Explain agarose gel electrophoresis 4. What is the significance of the lac operon 5. Explain colony hybridization 6. Explain PCR 7. Describe in brief Gene therapy 8. Explain Transgenic plants in brief **Long Answer Questions** 1. Explain DNA manipulating enzymes 2. Explain Ideal characters and types of vectors. 3. Describe Isolation of Genomic DNA from bacteria 4. Describe southern blotting 5. Explain gene mapping 6. Explain Construction of gene library 7. Discuss Recombinant Insulin 8. Describe Recombinant Hepatitis. 9. Explain Biohazards and ethical issues of genetic engineering

	Multiple choice questions 1. What is the function of restriction enzymes in genetic engineering? a) Copy DNA b) Cut DNA at specific sequences c) Amplify DNA d) Join DNA 2. What is the primary role of ligase in genetic engineering? a) Cut DNA at specific sequences b) Join DNA fragments c) Copy DNA d) Amplify DNA 3. The term "gene cloning" refers to what process in genetic engineering? a) Copying entire genomes b) Replicating genes in a laboratory setting c) Creating hybrid organisms d) Inserting genes into plasmids 4. Which of the following is NOT a potential application of genetic engineering? a) Disease treatment b) Agricultural crop improvement c) Space travel d) Environmental cleanup 5. What was the first genetically engineered product approved for human use? a) Genetically modified tomatoes b) Insulin c) Recombinant growth hormone d) Golden Rice 6. Which Nobel laureate was involved in the development of the polymerase chain reaction (PCR)? a) James Watson b) Kary Mullis c) Francis Crick d) Barbara McClintock 7. What is the purpose of gel electrophoresis in genetic engineering? a) Amplify DNA b) Separate and analyze DNA fragments c) Cut DNA at specific sequences d) Join DNA fragments 8. In the context of genetic engineering, what does the term "transgenic" mean? a) Genetically identical b) Genetically modified with genes from another species c) Genetically resistant to diseases d) Genetically engineered for longevity

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		20 Marks

127246 Practical 13 (Major): Applied Microbiology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127246	Applied Microbiology	2	60	2 Hrs	25(Ext) + 25 (Int)

Course Objectives

- Understand microbial analysis of food and dairy products for quality assessment and contamination detection.
- Apply microbiological methods in the examination of milk, curd, cheese, and other dairy products.
- Demonstrate techniques used in food preservation, fermentation, and microbial quality control.
- Understand the structure, properties, and qualitative analysis of biomolecules such as carbohydrates, proteins, lipids, and nucleic acids.
- Perform biochemical tests for identification and characterization of microorganisms.
- Understand and apply the principle of agarose gel electrophoresis for DNA separation.
- Learn proper handling of micropipettes, centrifuge, electrophoresis unit, and UV trans illuminator

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Identify and analyze carbohydrates, proteins, lipids, and nucleic acids using standard biochemical tests.
- Analyze microbial quality of food and dairy samples.
- Perform tests related to milk quality, pasteurization, and dairy fermentation.
- Detect spoilage microorganisms and evaluate food safety measures.
- Understand and apply the principle of agarose gel electrophoresis for DNA separation.
- Demonstrate correct preparation of agarose gel and electrophoresis setup
- Successfully isolate high-quality genomic DNA from biological samples.

Sr. No.	Contents of Practical
1	Estimation of proteins by Biuret method.
2	Estimation of DNA by DPA Method
3	Estimation of RNA by Orcinol Method
4	Isolation of genomic DNA from bacteria
5	Genetic recombination in bacteria. a) Transformation b) Conjugation

6	Isolation of fermentative mutant using physical mutagen (U.V.radiation)
7	Methylene blue reduction test (MBRT) for milk
8	Phosphatase test for pasteurized milk
9	Isolation and identification of lactobacilli from curd

Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning ➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Principles & techniques of Biochemistry &Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006 ➢ Laboratory manual in Biochemistry- J. Jayaraman ➢ Prescott, Hurley. Klein-Microbiology, 5th & 6thedition, International edition 2002 & 2006, McGraw Hill. ➢ Biochemistry – Stryer – W. H. Freeman & Co. – New York. ➢ Modern Food Microbiology by James Jay 6th ed ➢ Applied Dairy Microbiology by Martha & Steele ➢ Prescott, Hurley. Klein-Microbiology, 7 the edition, International edition, McGraw Hill. ➢ Pelczar M.J., Chan E.C.S and Krieg N.R., (2001)Microbiology, McGraw Hill Book Company, New York ➢ Text Book of Biochemistry by Dr. O. P. Agrawal. ➢ Essentials of Biochemistry by Dr. M. C. Pant. ➢ Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons, N.Y. 145 146 ➢ Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	**25 marks**	**Total**	**25 marks**

127247 Theory 3 (Major DSE 3): Fundamentals of Enzymology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127247	Fundamentals of Enzymology	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives

- To provide a deeper insight into the fundamentals of enzyme structure and function
- To impart knowledge about enzyme kinetics.
- To impart knowledge about enzyme catalysis and enzyme inhibition
- To provide a deeper insight into the applications of immobilized enzymes

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Describe the structure and function of enzymes
- Evaluate the importance of Enzyme kinetics
- Describe the mechanism of enzyme action
- Apply the knowledge of Enzymology in different fields

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I Basic concepts of enzymes	➢ General characteristics, of Enzymes ➢ Nomenclature, IUB classification of enzymes ➢ Definition with examples of Holoenzymes, apoenzymes, coenzymes, cofactors, activators, inhibitors, active site, metalloenzyme, marker enzyme, monomeric and oligomeric enzymes, Allosteric enzymes ➢ Unit of enzyme activity	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models:** use of model, Charts. **Problem-Solving Sessions:** Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for
Unit-II Mechanism of enzyme action	➢ Concept of enzyme and substrate specificity ➢ Chemistry of active Centre,	7 Hrs	7 marks	

	chemical modification by active site directed reagents. ➢ Mechanism of enzyme action (Lock & Key Model) ➢ Mechanism of action of lysozyme			interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable
Unit-III Enzyme kinetics	➢ Derivation of Michalies Menton equation for unisubstrate reaction, ➢ Km and its significance ➢ Lineweaver Burk plot and its limitation. ➢ Bisubstrate reactions- ping-pong mechanism	8 Hrs	8 marks	
Unit-IV Enzyme Technology	➢ Concept and methods of enzyme immobilization ➢ Microbial enzymes in textile, leather, wood industries and detergents ➢ Enzyme in clinical diagnostics ➢ Enzyme sensor and its application	7 Hrs	7 marks	

References	➢ General Enzymology, Dr. Nikhilesh Kulkarni, Mahindra Deshpande, Himalaya publishing house ➢ Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, T. Palmer (Ed), 2nd Ed., Horwood Publishing Chinchester, 2007. ➢ Enzymes: Catalysis, Kinetics and Mechanisms by N. S. Punekar, Springer. ➢ Enzymes:by Malcolm Dixon & Edwin Clifford Webb ➢ Fundamentals of Enzymology by Dr. N.L. Choudhary, Anjana Singh,Oxford Book Company ➢ Advanced Kinetics & Mechanisms, Contemporary Enzyme Kinetics and Mechanism, Author/Editor: Daniel L. Purich

Model Questions	**Short Answer Questions** 1. What are enzymes? 2. What is the active site? 3. What is a coenzyme? 4. What is marker enzyme 5. Explain Mechanism of action of lysozyme 6. Describe Km and its significance 7. Explain ping- pong mechanism 8. Explain Enzyme sensor **Long Answer Questions** 1. Explain Chemistry of active Centre *2.* Explain IUB classification of enzymes. 3. Describe Various theories of mechanism of enzyme action 4. Derive Michalies Menton equation for unisubstrate reaction 5. Explain Concept and methods of enzyme immobilization 6. Explain application of microbial enzymes in textile and leather industries. **Multiple choice questions** 1. What is the chemical nature of most enzymes? a) Lipid b) Carbohydrate c) Protein d) Nucleic acid 2. Enzymes increase the rate of reaction by: a)Increasing the activation energy b)Lowering the activation energy c)Increasing the kinetic energy of the substrate d) Consuming excess ATP 3. A non-protein organic molecule that is essential for enzyme activity is called a) Apoenzyme b)Coenzyme c)Holoenzyme d) Isozyme 4. Which enzyme class is responsible for the cleavage of bonds without the addition of water? a)Hydrolases b)Ligases c)Lyases d) Transferases 5. Which of the following models of enzyme-substrate interaction suggests that the active site is flexible and molds around the substrate? a)Lock and Key model b)Induced Fit model c) Substrate Strain theory

The distribution of marks for the Continuous Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		**20 Marks**

127248 Practical (Major DSE 3): Fundamentals of Enzymology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127248	Fundamentals of Enzymology	2	60	2 Hrs	25(Ext) + 25 (Int)

Course Objectives

- Apply standard microbiological and biochemical techniques for screening enzyme-producing microorganisms.
- Develop laboratory skills for the isolation, detection, and characterization of enzymes from biological sources
- Investigate the effects of environmental and reaction parameters such as temperature, pH, and substrate concentration on enzyme activity
- Understand the principles of enzyme activity, enzyme kinetics, and factors affecting enzymatic reactions

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Determine and interpret the activities of important microbial enzymes such as amylase, protease, and urease using standard biochemical methods.
- Demonstrate screening of microorganisms for extracellular enzyme production
- Evaluate the influence of temperature, pH, and substrate concentration on enzyme activity and explain the observed effects using enzyme kinetics principles
- Determine characteristic enzyme parameters and relate them to enzymatic starch hydrolysis

Sr. No.	Contents of Practical
1	Determination of Amylase Activity in bacteria Using Starch Hydrolysis Assay
2	Determination of protease Activity in bacteria Using Casein Digestion Assay
3	Determination of urease Activity in bacteria
4	To study effect of temperature on activity of Salivary Amylase or any other suitable enzyme
5	To study effect of pH on activity of Salivary Amylase or any other suitable enzyme
6	To study effect of substrate concentration on salivary amylase or any other suitable enzyme

Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning

	➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. ➢ Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 ➢ Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 ➢ Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Practical manual in Biochemistry by Jairaman

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 marks	Total	25 marks

127249 Theory 4 (Major DSE 4): Microbial Biotechnology and Entrepreneurship							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127249	Microbial Biotechnology and Entrepreneurship	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives

- To impart knowledge about the concept and scope of microbial Biotechnology
- To make the students aware about the use of microbes for renewable energy
- To impart knowledge about role of Microbes for sustainable environment
- To impart knowledge about Entrepreneurship opportunities in Microbial Biotechnology

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Evaluate the role of microbial Biotechnology for sustainability
- Apply the knowledge of microbial Biotechnology in bioenergy
- Apply the knowledge of microbial Biotechnology in environmental management
- Discover Entrepreneurship opportunities in Microbial Biotechnology

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I Microbial Biotechnology And its industrial applications	➢ Introduction to microbial Biotechnology ➢ Industrial applications of Microbial Biotechnology for production of: 1. Biosurfactants 2. Biopolymers 3. Biosensor 4. Bioplastics	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models:** use of model, Charts. **Problem-Solving Sessions:** Organize regular problem-solving sessions. **Virtual Labs:** Explore virtual labs and simulations to enhance
Unit-II Microbes for Renewable energy	➢ Biogas ➢ Biodiesel ➢ H2 gas ➢ Biomass	7 Hrs	7 marks	

Unit-III Microbial Biotechnology for Environmental sustainability	➢ GEMS for environmental cleaning ➢ Bioremediation ➢ Biomining ➢ Garbage decomposition	8 Hrs	8 marks	understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions. **Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts. **Inquiry-BasedLearning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable
Unit-IV Industrial Microbiology Based Entrepreneurship	➢ Making Money from Microbes ➢ Concept of Microbiological Based Entrepreneurship ➢ Microbiology for self-Employment and self-productivity ➢ Strategies for Mass Multiplication ➢ Business plan for microbial production	7 Hrs	7 marks	

References	➢ Microbial Technology: Pepller H.J. (Vol. I & II) ➢ Biotechnology by B.D. Singh ➢ Textbook of Biotechnology by H.K. Das ➢ Microbial Technologies and Their Applications: By Santosh Kumar Karn and Anne Bhambri. Microbiology Research Advances ➢ Microbial Biotechnology: Fundamentals of Applied Microbiology: By Alexander N. Glazer and Hiroshi Nikaido. ➢ Industrial Microbiology Based Entrepreneurship: Making Money from Microbes: 42 (Microorganisms for Sustainability) by Natarajan Amaresan , Dhanasekaran Dharumadurai, Diana R. Cundell

Model Questions	

Short Answer Questions

1. Describe biopolymers
2. Describe the role of microbial biotechnology for production of Biosurfectants
3. Describe biogas
4. Describe biodiesel
5. Describe Garbage decomposition by microbes
6. Describe Bioremediation

Long Answer Questions

1. Describe in detail microbial production of bioplastic
2. Describe in detail microbes for production of biosensorts
3. Explain microbial production of Biogas
4. Describe biomass
5. Explain GEMS for environmental cleaning
6. Explain Biominin

Multiple choice questions

1) Biosurfactants are mainly used for:

a) Food preservation b) Reducing surface tension c) DNA replication d) Photosynthesis

2) Which is a common biopolymer?

a) Polyethylene b) Polypropylene c) Cellulose d) PVC

3) Biosensors are widely used in:

a) Weather forecasting b) Glucose monitoring c) Mining d) Construction

4) Biogas mainly contains:

a) Nitrogen b) Methane c) Oxygen d) Hydrogen

5) Bioremediation is:

a) Metal extraction b) Pollution removal using organisms

c) Food processing d) Drug synthesis

6) Microbiological entrepreneurship involves:

a)Using microbes for commercial production b)Mining coal

c) Manufacturing steel d) Construction work

7) A business plan should include:

a)Marketing strategy b) Financial analysis

c) Production plan d) All of the above

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities / GD/ Seminar/ Poster presentation, quiz etc.(any two activity 5 mark each)		10 Marks
Total		20 Marks

127250 Practical (Major DSE4): Microbial Biotechnology and Entrepreneurship							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	127250	Microbial Biotechnology and Entrepreneurship	2	60	2 Hrs	25 (Ext) + 25 (Int)

Course Objectives

- Understand the role of microorganisms in environmental management, waste degradation, and bioremediation.
- Apply microbiological techniques for the isolation, cultivation, and characterization of environmentally important microorganisms.
- Explore microbial applications in biodegradation, biosurfactant production, biomass generation, and composting processes.
- Investigate microbial diversity in contaminated environments such as oil-polluted and metal-polluted soils.

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Demonstrate proficiency in sampling, isolation, cultivation, and maintenance of environmental microorganisms.
- Isolate and identify microorganisms involved in biodegradation of organic waste and environmental pollutants.
- Evaluate the role of microorganisms in biosurfactant production, biomass generation, and waste management applications.
- Prepare and assess microbial products such as bio herbicides and compost for sustainable agricultural practices.

Sr. No.	Contents of Practical
1	Preparation of compost from kitchen waste
2	Microscopic examination of compost
3	Enumeration and Comparison of Microbial Load in Garden Soil, Compost, and Roadside Soil
4	Primary screening (Qualitative test) of microorganisms for biosurfactant production
5	Preparation of bio- herbicides
6	Production of biomass
7	Isolation and screening of microorganisms from plastic polluted/ metal polluted soil samples

8	Shelf life study of any Microbiology-Based Product
9	Design of Packaging and Label for a Microbiology-Based Product (Example: Biofertilizer, probiotics drink, etc.)
10	Preparation of report for microbiology based small scale industry

Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning ➢ Collaborative Learning: Group-based activities, post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Microbial Technology: Pepller H.J. (Vol. I & II) ➢ Biotechnology by B.D. Singh ➢ Textbook of Biotechnology by H.K. Das ➢ Microbial Technologies and Their Applications: By Santosh Kumar Karn and Anne Bhambri. Microbiology Research Advances ➢ Microbial Biotechnology: Fundamentals of Applied Microbiology: By Alexander N. Glazer and Hiroshi Nikaido.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 marks	Total	25 marks

127251 Theory 6 (Minor): Molecular Biology and Genetic Engineering							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127251	Molecular Biology and Genetic Engineering	2	30	2 Hrs	30(Ext) + 20 (Int)

Course Objectives

- Understand the fundamental concepts of gene multiplication
- Explain the molecular mechanisms involved in gene expression, including transcription and translation
- To provide students the recent knowledge of recombinant DNA Technology and genetic engineering
- To impart knowledge on the concept of genetic engineering including the techniques, applications and limitations.

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Explain the concept and mechanisms of gene multiplication and gene amplification.
- The regulation of gene expression through operons, transcription factors
- Describe the concept of recombinant DNA Technology and genetic engineering
- Apply the knowledge of different techniques used in Genetic Engineering

Unit System	Contents	Workload allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit-I Gene multiplication	➢ Concept of gene – Definition of Gene, Muton, recon, cistron, gene within gene, split gene. ➢ Replication of DNA- Modes of replication, (Conservative, Semiconservative and Dispersive). Experiment of Meselson and Stahl to prove semiconservative mode of replication.	8 Hrs	8 marks	Chalk & Board. **Interactive Lectures:** Use of multimedia presentations, interactive slides, and animations. **Hands-On Models:** use of model, Charts. **Problem-Solving Sessions:** Organize regular problem-solving sessions. **Virtual Labs:** Explore

	➢ Mechanism of replication with enzymes involved, models of replication: Knife and fork, rolling circle. ➢ DNA repair mechanisms- light and dark.			virtual labs and simulations to enhance understanding of the topic. **Flip-Class:** Assign readings or video lectures, assignment as homework and use class time for interactive discussions.
Unit-II Gene regulation and expression	➢ Concept of Genetic code ➢ Outline of Translation (Protein synthesis) ➢ Gene regulation Mechanisms - lacoperon Trp operon	7 Hrs	7 marks	**Concept Maps:** Ask students to create own concept maps that illustrate the relationships between different concepts.
Unit-III Tools of Genetic Engineering	➢ Introduction to basic technique of genetic engineering and Enzymes for splicing: Restriction endonucleases. ➢ Range of DNA manipulating enzymes: Nucleases, Ligases, Polymerases, DNA modifying enzymes, Topoisomerases. ➢ Vectors: Ideal characters and types: Plasmid pBR322, Cosmid and Bacteriophage (Lambda) ➢ Concept of competent cells	8 Hrs	8 marks	**Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. Any other innovative pedagogy as applicable
Unit-IV Techniques of genetic engineering	➢ Isolation of Genomic DNA from bacteria ➢ Analysis of DNA fragment size by agarose gel electrophoresis.	7 Hrs	7 marks	

	➢ Identification of transformed cell (e.g. Antibiotic resistance gene in Plasmid) ➢ Selection of clones: Direct (colony hybridization) and Indirect method (southern blotting).			

References	➢ Fundamental Bacterial Genetics by Nancy Trun and JenanineTrumphy (2003), Publisher: Blackwell Publishers. ➢ Genetics a conceptual approach (5th Ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company ➢ Genetics A Molecular Approach (2nd / 3rd Ed.) by Peter J Russell (2006) ➢ Modern Microbial Genetics (2nd Ed.) by Uldis N. Streips, Ronald Yasbin. Publisher: Wiley-Liss, Inc. ➢ Microbial Genetics by Maloy et.al. 1994. Jones and Bartlett Publishers. ➢ Molecular Genetics of Bacteria by J.W.Dale 1994 John Wiley and Sons. ➢ Gene XII by Lewin Oxford University press. 2017 ➢ Organization of Prokaryotic genome. 1999 by Robert L Charlebois, ASM Publications. ➢ Recombinant DNA by Watson J.D. ➢ Principles of gene manipulation. 1994. Old & Primrose, Blackwell Scientific Publications ➢ Molecular Cloning. 3 volumes. Sambrose and Russell, 2000. CSH Press. ➢ Genetics A Molecular Approach (2nd / 3rd Ed.) by Peter J Russell (2006) ➢ Recombinant DNA by Watson J.D. ➢ Recombinant DNA:-James. D. Watson, John. Tooze, David.Kutz ➢ Introduction to Genetic Engineering: - Nicholas ➢ An Introduction to Genetic Analysis: - David Suzuki, Anthony. Griffths
Model Questions	**Short Answer Questions** 1. Name the enzymes involved in transcription 2. What is the significance of the lac operon 3. Define genetic Engineering 4. Describe Restriction endonucleases 5. Explain agarose gel electrophoresis 6. Explain colony hybridization

Long Answer Questions

1. Explain the concept, mechanisms, and significance of gene multiplication.
2. Explain the mechanism of translation with suitable diagrams
3. Explain the lac operon model and its significance
4. Define mutation and classify different types of mutation
5. Explain DNA manipulating enzymes
6. Explain Ideal characters and types of vectors.
7. Describe Isolation of Genomic DNA from bacteria
8. Describe southern blotting

Multiple choice questions

1. Gene multiplication is also known as

a) Gene deletion b) Gene amplification c) Gene mutation d) Gene inversion

2. The lac operon is an example of

a) Repressible operon b) Inducible operon c) Structural gene d) Muton

3. Which molecule acts as an inducer in lac operon?

a) Glucose b) Lactose c) Maltose d) Fructose

4. What is the function of restriction enzymes in genetic engineering?

a) Copy DNA b) Cut DNA at specific sequences c) Amplify DNA d) Join DNA

5. What is the primary role of ligase in genetic engineering?

a) Cut DNA at specific sequences b) Join DNA fragments c) Copy DNA d) Amplify DNA

6. The term "gene cloning" refers to what process in genetic engineering?

a) Copying entire genomes b) Replicating genes in a laboratory setting c) Creating hybrid organisms d) Inserting genes into plasmids

7. Which of the following is NOT a potential application of genetic engineering?

a) Disease treatment b) Agricultural crop improvement c) Space travel d) Environmental cleanup

8. What was the first genetically engineered product approved for human use?

a) Genetically modified tomatoes b) Insulin c) Recombinant growth hormone d) Golden Rice

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activity 5 mark each)		10 Marks
Total		20 Marks

127252 Practical 6 (Minor): Molecular Biology and Genetic Engineering							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127252	Molecular Biology and Genetic Engineering	2	60	2 Hrs	25(Ext) + 25 (Int)

Course Objectives

- Understand the chemical principles underlying the qualitative and quantitative estimation of biomolecules such as proteins, DNA, and RNA.
- Develop laboratory skills in the extraction, purification, and analysis of nucleic acids from microbial sources.
- Perform spectrophotometric and colorimetric assays for the estimation of biological macromolecules.
- Learn the principles and applications of agarose gel electrophoresis in molecular biology.

Course Outcomes: Upon completion of this course successfully, students would be able to

- Perform quantitative estimation of proteins, DNA, and RNA using standard biochemical methods.
- Apply colorimetric techniques to determine the concentration of biomolecules and interpret analytical results.
- Isolate genomic DNA from bacterial cultures using appropriate extraction and purification procedures.
- Demonstrate the principles and applications of agarose gel electrophoresis for the separation and analysis of nucleic acids.

Sr. No.	Contents of Practical
1	Isolation of genomic DNA from bacteria
2	Demonstration of Agarose Gel Electrophoresis
3	Estimation of DNA by DPA Method
4	Estimation of RNA by Orcinol Method
5	Isolation of fermentative mutant using physical mutagen (U.V. radiation)
6	Detection of streptomycin (antibiotic resistant mutant) by replica plating technique
Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning ➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation.

	➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. ➢ Principles & techniques of Biochemistry &Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006 ➢ Laboratory manual in Biochemistry- J. Jayaraman ➢ Prescott, Hurley. Klein-Microbiology, 5th & 6thedition, International edition 2002 & 2006, McGraw Hill. ➢ Biochemistry – Stryer – W. H. Freeman & Co. – New York. ➢ Fundamentals of Biochemistry. Jain, J. L..et al, S. Chand, India Limited, 2004 ➢ Modern Food Microbiology by James Jay 6th ed ➢ Applied Dairy Microbiology by Martha & Steele ➢ Prescott, Hurley. Klein-Microbiology, 7 the edition, International edition, McGraw Hill. ➢ Text Book of Biochemistry by Dr. O. P. Agrawal. ➢ Essentials of Biochemistry by Dr. M. C. Pant. ➢ Text book of Biochemistry by West and Todd. ➢ Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons, N.Y. 145 146 ➢ Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation**	
Performance of any two experiments	20 marks	Attendance & Students performance	10 Marks
Viva-voce	05 marks	Practical Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 marks	Total	25 marks

127253 VSC- Lab Practical 14: Quality Control for Food and Dairy Products							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	127253	Quality Control for Food and Dairy Products	2	60	2 Hrs	50 (Int)

Course Objectives

- Develop skills in the microbiological examination and quality assessment of food and dairy products.
- Perform standard microbiological techniques for enumeration and analysis of microorganisms in food samples.
- Understand the principles and significance of pasteurization in dairy processing.
- Gain hands-on experience in the preparation of fermented and value-added dairy products

Course Outcomes:

Upon completion of this course successfully, students would be able to

- Perform microbiological analysis of food and dairy products using standard laboratory techniques.
- Determine microbial load in food and milk samples through standard plate count methods and assess product quality.
- Evaluate the effectiveness of milk processing and preservation techniques using phosphatase and methylene blue reduction tests.
- Prepare fermented and processed dairy products such as curd, cheese, and paneer using standard procedures.

Sr. No.	Contents of Practical
1	Microbial examination of food by standard plate count
2	Quality control study of package/ canned food by food adulteration methods
3	Comparative studies of different milk samples by standard plate count
4	Comparative studies of different milk samples by methylene blue reduction test
5	To study the Pasteurization of milk by phosphatase test
6	Quality control study of milk by adulteration test
7	Preparation of curd
8	Preparation of cheese
9	Preparation of paneer
10	Visit to the food/dairy industry and prepare a report

Incorporation of Pedagogies	➢ Experiential Learning: Hands-on experimentations. ➢ Inquiry-Based Learning ➢ Collaborative Learning: Group-based activities, Post-experiment discussions encourage critical evaluation. ➢ Virtual Labs: Explore virtual labs and simulations to enhance understanding of the topic
References	➢ Food Microbiology by Frazier 5th ed ➢ Modern Food Microbiology by James Jay 6th ed ➢ Applied Dairy Microbiology by Martha & Steele ➢ Prescott, Hurley. Klein-Microbiology, 7 the edition, International edition, McGraw Hill. ➢ Pelczar M.J., Chan E.C.S and Krieg N.R., (2001)Microbiology, McGraw Hill Book Company, New York ➢ Hammer B.W and Babal(1948), Dairy Bacteriology, Prentice Hall Incorporated, London. 8. ➢ Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern ➢ Food Microbiology, 7th Edn. Springer Publishers ➢ Food Microbiology :Fazier W.C. &Westhoff D.C. FermentedFoods (Vol.7) : Rose A.A. ➢ IndustrialMicrobiology : Prescott S.C. & Dunn C.G. ➢ IndustrialMicrobiology : Miller B.M. & W. Litsky ➢ IndustrialMicrobiology : A.H. Patel ➢ MicrobialTechnology :Pepller H.J. (Vol. I & II) ➢ Industrial Microbiology: Casida L.E. ➢ Principles of Fermentation: Stanbury, Peter F. &Technology Allan. Whitaker ➢ Outlines of Diary Bacteriology : Sukumar De 21 ➢ Modern Food Microbiology: Jay, Mames M. ➢ Principles of Industrial: Rhodes & Fletcher. Microbiology ➢ Industrial Fermentation: Under Kofler & Hick. Vol. I & II ➢ Dairy Microbiology: Foster Etal.

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

Course Category: Internship / Apprenticeship/ OJT

127254 Internship/ Apprenticeship/ OJT (On Job Training)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	127254	Internship / Apprenticeship/ OJT (On Job Training)	4	80	--	100

Course Objectives:	1. To provide hands-on training in Microbiology-related industries, laboratories, skill India, or the research project in research organizations. 2. To expose students to industrial practices, instrumentation, quality control, and safety procedures. 3. To enhance problem-solving, teamwork, communication, and technical skills. 4. To create awareness regarding entrepreneurship and employment opportunities in microbiology.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Apply theoretical chemistry concepts in practical and industrial environments. 2. Operate and understand basic analytical instruments and laboratory techniques. 3. Demonstrate professional ethics, laboratory safety, and teamwork. 4. Analyze microbiological processes, observations, and experimental data effectively. 5. Prepare technical reports and communicate scientific findings professionally. 6. Explore employability and entrepreneurship skills in chemistry-related sectors.

Guidelines/ SOP for Internship / Apprenticeship/ OJT

For understanding key principles of Internship/Apprenticeship/OJT operational guidelines and implementation strategy please refer

1. https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-Internship-Guidelines.pdf
2. https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf

As per NEP 2020, students of B Sc. III SEM VI need to undertake Internship / Apprenticeship/ OJT for FOUR (4) credits i.e. 100 Marks.

The guidelines for Internship / Apprenticeship/ OJT are as follows:

1. **Credit: 04**
2. **Duration: 120 Hrs**
3. **Internship Period**: Ideally, the internship should be completed during the summer break between the second and third year. Students who are unable to complete the internship during this period

must ensure its completion by the end of the VI semester, either in a part-time manner duringSemesterV,orduringtheDiwalibreak,orwinterbreakorthroughanalternative arrangement subject to prior approval by the parent institution(University/ School/College).

4. **Internship Categories:**

i. **Internship for enhancing the employability:** Employability is asset of skills and attributes developed through a range of experiences at workshops, workplaces and industry.

ii. **Internship for developing the research aptitude and practical exposure:** Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, handling lab equipment, policy framework and various other aspects in pursuing quality research.

5. **Implementation and assessment**: For implementation and assessment of this vertical a separate SOP or relevant document that shall be provided by the University will be applicable.
6. These can be implemented through:
    1. Industries
    2. Research labs
    3. Government testing laboratories
    4. Colleges/departments
    5. MSMEs and startups
    6. Online/virtual internships with report and viva evaluation

Some suggested forms of Internship / Apprenticeship/ OJT are:

Laboratory and Analytical Training:

1. Water quality testing laboratory internship
2. Soil and bio fertilizer analysis training
3. Food and dairy testing laboratory apprenticeship
4. Edible oil analysis and quality control training
5. Pharmaceutical quality control laboratory training
6. Clinical pathology and diagnostic laboratory exposure
7. Environmental monitoring and pollution analysis internship
8. Industrial analytical microbial laboratory training

Microbiology Industry-Based OJT

1. Internship in microbiology base manufacturing units
2. Soap, detergent, and cosmetic industry apprenticeship
3. Bio fertilizer and bio pesticide formulation training
4. Distillery, sugar, or fermentation industry exposure
5. Pharmaceuticals and food product finishing industry training

Research and Academic Exposure

1. Project based internship in university or research laboratories or premier institutes like IITs/IISERs etc.
2. Microbiological instrumentation handling training in reputed research laboratories.
3. Nonmaterial synthesis and characterization exposure.
4. Scientific documentation and laboratory management training.

Entrepreneurship and Skill-Based OJT

1. Small-scale microbial product preparation: Soap, Sanitizer, Bio detergent, Herbal products etc.
2. Food preservation and quality analysis training
3. Entrepreneurship in microbial products and formulations
4. Microbiological product preparation and packaging training

Community Engagement and Rural Development (CERD) Services for Microbiology Students

1. Health and Hygiene Awareness
2. Safe Drinking Water and Sanitation
3. Environmental Microbiology
4. Agricultural Microbiology Extension
5. Food Safety and Fermentation
6. Disease Prevention and Public Health
7. School Outreach Programs
8. Skill Development and Entrepreneurship
9. Community-Based Research

References	https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-Internship-Guidelines.pdf https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf
Model Questions:	**NA**