

Shri Manibhai Virani and Smt. Navalben Virani Science College

(Autonomous), Rajkot

Affiliated to Saurashtra University, Rajkot

11th Academic Council held on 20th June, 2023

APPENDIX J.1

Enclosures I to V of 13th BoS – Microbiology held on 22nd May, 2023



**SarvodayaKelavaniSamaj Managed
Shri ManibhaiVirani&Smt.NavalbenViraniScienceCollege, Rajkot
(Autonomous)**

Affiliated to SaurashtraUniversity, Rajkot

Reaccredited at the “A” Level (CGPA 3.28) by NAAC

“STAR” College Scheme & Status by MST-DBT

A College with Potential for Excellence – CPE (Phase - II) by UGC

Accredited at the G-AAA Highest Grade ‘A-1’ Level by KCG, Govt. of Gujarat

UGC-DDU KAUSHAL Kendra

GPCB-Government of Gujarat approved Environmental Audit Centre

SCHEME OF LEARNING AND EVALUATION

Of

B. Sc. MICROBIOLOGY

(W.e.f June 2021)

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot
(Autonomous)
Affiliated to Saurashtra University, Rajkot
Department of Microbiology
B.Sc. MICROBIOLOGY PROGRAMME
Regulations for Students Admitted from A.Y. 2021-2022& Onwards

ELIGIBILITY

Candidate who has passed Higher Secondary Certificate (10+2) examination with Science subjects in respective streams of Gujarat State or any other examination recognized as equivalent thereto with a good academic record, shall be eligible for admission, subject to such other conditions prescribed by the Parent University and State Government from time to time. All admissions are provisional and subject to the approval of Parent University.

LATERAL ENTRY

Candidates seeking admission directly in third semester of B.Sc. Microbiology must have passed examination of Diploma in Pharmacy or relevant subjects will be eligible for admission. A result of this type of candidate will be declared by considering his/her marks of semester 3 to 6 in aggregate and accordingly class will be awarded.

DURATION OF THE PROGRAMME

The Program

1. Shall extend over a period of three years comprising of six semesters for lateral entrants
2. Comprises of two semesters in one academic year wherein each semester normally will be of minimum 90 teaching days.

CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses based on their interest. Mainly, each course is worth a certain number of credit points, determined by different criteria including learning outcome, contact hours etc.

The following mechanism is adopted for the purpose of computation of credits earned by the students:

- | | |
|----------------------------------------|------------|
| a) 1-hour instruction of Theory | = 1 Credit |
| b) 2-3 hours instruction of Tutorial | = 1 Credit |
| c) 2-3 hours instructions of Practical | = 1 Credit |

OUTCOME BASED EDUCATION (OBE)

Outcome based education is based on revised Bloom Taxonomy and is a learner-centric teaching and learning methodology in which the course delivery and assessment are planned to achieve stated objectives and outcomes. It focuses on measuring students performance i.e. outcomes at different levels. OBE method of learning is adopted.

STRUCTURE OF THE PROGRAMME

UG program shall have a curriculum comprising theory and practical (separate / in built with theory) courses with a specified syllabus. The curriculum of the program is a blend of Language Courses, Core Courses, Interdisciplinary Courses (IDC), Discipline Specific Electives (DSE), Trans-disciplinary Electives (TDE) and Ability Enhancement Courses (AEC) shall be offered.

MEDIUM OF INSTRUCTION AND EXAMINATIONS

The medium of instruction and examinations shall be English, except for courses on Languages other than English.

EVALUATION

The evaluation shall generally comprise of Continuous Internal Assessment (CIA) and Semester End Examination (SEE) with percentage weightage as specified below, unless specified otherwise in the Scheme of Learning and Evaluation.

Components	Theory Courses	Practical Courses
Continuous Internal Assessment (CIA)	Varies from 30 percent to 60 percent based on the nature of course.	Varies from 40 percent to 100 percent based on the nature of course.
Semester End Examination (SEE)	Varies from 70 percent to 40 percent based on the nature of course.	Varies from 40 percent to 60 percent based on the nature of course.

COMPLETION OF PROGRAM TO EARN THE DEGREE CERTIFICATE

The University shall publish the result after evaluation and with the recommendations of Result Passing Board at the end of each semester. On approval / ratification of the results by the Academic Council, the student will be recommended to Governing Body for the award of the degree provided that the student have earned all the credits towards mandatory course / components as mentioned in Scheme of Learning and Evaluation.

MINIMUM QUALIFICATION FOR APPOINTMENT OF FACULTY MEMBER

As per norms of UGC and./or other related Regulatory body

**Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot
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**Department of Microbiology
B. Sc. MICROBIOLOGY**

VISION OF THE DEPARTMENT

Our vision is to produce highly qualified and competent microbiologists with expertise in all the relevant areas, to develop and maintain a strong and supportive research programme to complement our national needs while strengthening local relevance and to rise as centre of excellence and knowledge in the subject of Microbiology

MISSION OF THE DEPARTMENT

The Mission of Microbiology Department is to promote good quality education, research and to provide the most rigorous and inspiring training in the discipline of Microbiology with greater significance of application in all relevant areas. The Department strives to educate and mentor students to:

- Acquire practical skills necessary for operation and maintenance of small and medium scale industry and research institute,
- Be aware of the role of microorganisms in various aspects of life processes and understand their importance in agriculture, environment, food, health, and other areas,
- Apply microbiological techniques and technologies to the betterment of human life, environment and national economy,
- Contribute to the pursuit of knowledge by contributing meaningfully in the area of Research in Microbiology

OBJECTIVES OF THE PROGRAMME

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation:

1. This programme will enable students to understand the basic anatomy, physiology, diversity, and genetics of microorganisms including viruses, bacteria, protozoa, algae and fungi, and exploit their interactions with environment and human beings.
2. The Curriculum is designed to impart to students the skill to operate basic and advanced instruments used for analysis of various biomolecules.
3. This programme will enable students to acquire knowledge on the Microbiology, Cell Biology, Microbiology, Immunology, Bioprocess Technology and Molecular Biology to enable them to understand emerging and advanced concept in modern biology and help them to take their career in this field.
4. After completion of the programme, the students will be able to acquire the necessary theoretical and practical competencies in Microbiology to enable them to undertake higher studies in recognized Institutions of advance learning and engage gainful self-employment.
5. The Programme is intended to help the students to be the innovative and versatile personalities in the field of Life Science with quality education and provide the skilled manpower required by Research and Development, Institutions of Higher Learning and Industry.

GRADUATE ATTRIBUTES

- **Academic excellence:** Ability to identify key questions, research and pursue rigorous evidence-based arguments.
- **Critical Thinking and Effective communications:** Analysis and evaluation of information to form a judgment about a subject or idea and ability to effectively communicate the same in a structured form.
- **Global Citizenship:** Mutual understanding with others from diverse cultures, perspectives and backgrounds
- **Life Long Learning:** Open, curious, willing to investigate, and consider new knowledge and ways of thinking

PROGRAM EDUCATIONS OBJECTIVES (PEOs)

This programme will produce Graduates who will attain following PEOs after few years of graduation	
PEO 1	Core competency: will develop the competency to pursue higher education, successful professional career, or be an entrepreneur with synergistic combination of the knowledge and skills of Microbiology and allied sciences
PEO 2	Breadth of knowledge: will show the ability to critically analyse scientific data, drawing objective conclusions from it and apply this knowledge to independently design, and execute small research problems with the help of integrated knowledge of Microbiology and other domains for societal and human welfare.
PEO 3	Preparedness: will have the potential to take any task or assignment in the capacity of a leader or team member in the chosen occupations or careers and will reflect an aptitude and ability for contribution in academics, entrepreneurship, and research, equipped with good communication skills.
PEO 4	Professionalism: will possess strong professional ethics and expertise to fulfil moral duties towards their profession, community, society and nation at large.
PEO 5	Learning environment: will show readiness for lifelong learning necessary to meet the ever evolving professional, social and personal demands through ethical, interpersonal and team skills.

PROGRAM OUTCOMES:

After completion of the B.Sc. Microbiology programme, the Graduate will be able to:		
PO 1	:	Domain knowledge: Demonstrate an understanding of fundamental principles of Microbiology, its applications and scope, along with an ability to identify beneficial and harmful role of microorganisms for the benefit of Science and Society
PO 2	:	Problem analysis: Accurately identify and critically analyse pertinent problems in the field of Applied Microbiology and various domains of Biological sciences.
PO 3	:	Design/development of solutions: Search for and successfully arrive at viable conclusions/solutions pertaining to various aspects of life sciences using right approach and appropriate tools and techniques
PO 4	:	Conduct investigations of complex problems: Ability to investigate any complex problems related to Microbiology and other life science with the use of appropriate experimental tools/techniques/equipment.
PO 5	:	Modern tool usage: Understand standard operating procedures, safety measures and acquire in-depth technical competence to handle the basic laboratory instruments, and develop the skills to locate and retrieve scientific information with modern data search tools.
PO 6	:	The Microbiologist and Society: Demonstrate the ability to understand the role of scientific developments in a changing world from the disciplinary perspective as well as in relation to its professional and everyday use, with an insight into one's role in society and act in an honest and consistent manner based on a strong sense of self and personal values.
PO 7	:	Environment and sustainability: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO 8	:	Ethics: Commitment to professional ethics and responsibilities.
PO 9	:	Individual and team work: Exhibit the potential to effectively accomplish tasks as a leader or a member of a team as well as independently in multidisciplinary settings.
PO 10	:	Communication: Communicate effectively in spoken and written forms as well as through digital media with scientific community, society, and fellow mates.
PO 11	:	Project management and finance: Demonstrate knowledge and scientific understanding to design a research project and manage its execution to generate new scientific insights, innovations in Microbiology research and exhibit organizational skills for able management of time and resources.
PO 12	:	Life-long learning: Able to recognize the need to undertake life-long learning and acquire the capacity to build on critical thinking skills for periodic updating of scientific knowledge and its application.

PROGRAM SPECIFIC OUTCOMES (PSOs) for B. Sc. Microbiology programme

After completion of the programme, the Graduate will:	
PSO1	: Acquire knowledge on the fundamentals of Microbiology for sound and solid base which enables them to understand the emerging and advanced concepts in life sciences
PSO2	: To equip the students with knowledge, skill and inspiration to pursue higher education and research in Microbiology and allied fields in reputed institutes at national and international level.
PSO3	: Be able to understand fundamental principles of Microbiology to find innovative solutions for environment, agriculture, and health related issues at local and global level.
PSO4	: Apply the knowledge of Microbiology, preferably with the synergistic application of basic understanding of other allied fields, for finding sustainable ethical solutions to existing global problems in compliance to the SDGs
PSO5	: Become competent and eligible to appear in various competitive exams, getting placement in government and private sectors of academia, research and industries, and become a successful Microbiologist serving the Nation.

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Department of Microbiology

B. Sc. MICROBIOLOGY

SCHEME OF LEARNING AND EVALUATION

For the students admitted from the A.Y. 2021-22 & onwards

Semester-I									
Course Code	Course	Contact Hrs/wk.			SEE Duration hrs	Maximum Marks			Credits
		T	Tu	P		CIA	SEE	Total	
Part-I									
21ULCEN101	English-I – Development of Functional English	3	-	-	3	40	60	100	3
	Part-I Total	3	0	0		40	60	100	3
Part-II									
21UMBCC101	Core1: Fundamentals of Microbiology (F1)	4	-	-	3	30	70	100	4
21UMBCC102	Core2: Microbial Growth and Control (F2)	4	-	-	3	30	70	100	4
21UMBID101	IDC-1: Zoology-1 Systematics and Anatomy	3	-	-	3	30	70	100	3
21UMBCC103	Core Practical-1 Basic Microbial Techniques	-	-	6	6#	40	60	100	4
21UMBID102	IDC- Practical - 1: Zoology-1: Systematics and Anatomy	-	-	6	3	40	60	100	2
	Core Enrichment – 1: Concept to Practice Course		1	-	-	(20)	Evaluation at the end of Semester - IV		
	Part-II Total	11	1	12		170	330	500	17
Part-III: Ability Enhancement Courses									
21AESD101	AECC I: Introduction to SDG (online course)	-	-	-	-	-	-	Remarks	Audit course
	AECC II: Environmental Conservation and Sustainable Development	1	-	-	-	Evaluation at the end of 2 nd Semester			-

	AECC III: Human Values for Holistic Living	1	2*	-	-	Evaluation at the end of 2 nd Semester			-
	FS 3: Career Acceleration Programme	2*							
	Part-III Total	2	-	-		100	0	0	0
	Total (Part-I to Part-III)	16	1	12	-	210	390	600	20
		29				600			

3hrs on day1 and 3 hrson day 2;

* Beyond Academic hours

() Final evaluation for 100 marks be made at the end of Semester IV, which include 20 marks CIA in Semesters I, II, and III each, and of 40 marks in Semester IV.

Semester-II									
CourseCode	Course	Contact Hrs/wk.			SEE Duration hrs	Maximum Marks			Credits
		T	Tu	P		CIA	SE E	Total	
Part-I									
21ULCEN2	English II – Functional English	3	-	-	3	40	60	100	3
	Part-I Total	3	0	0		40	60	100	3
Part-II									
21UMBCC201	Core3: Microbial Taxonomy and diversity (F)	4	-	-	3	30	70	100	4
21UMBCC202	Core4: Basic Biochemistry (F)	4	-	-	3	30	70	100	4
21UMBCC203	Core 5: Cell Structure and Organization (F)	4	-	-	3	30	70	100	4
21UMBID201	IDC-2: Botany – Medicinal Botany	3	-		3	30	70	100	3
21UMBCC204	Core Practical – 2 Microbial Diversity and Biochemistry	-	-	6	6#	40	60	100	2
21UMBID202	IDC-2: Practical: Botany	-	-	6	3	40	60	100	2
	Core Enrichment – 2: Concept to Practice Course		1		-	(20)	Evaluation at the end of Semester – IV		
	Part-II Total	15	1	12		200	400	600	19
Part-III: Ability Enhancement Courses									
21xxx	AECC II: Environmental Conservation and Sustainable Development	1	-	-	-	Remarks			2
21xxxx	AECC III: Human Values for Holistic Living	1	2*	-	-	Remarks			3
	FS 3: Career Acceleration Programme	2*							
	Part-III Total	2	-	-		0	0	0	5
	Total (Part-I to Part-III)	20	1	12	-	240	460	700	27
		33				700			

3hrs on day1 and 3 hrs on day 2;

* Beyond Academic hours

(Final evaluation for 100 marks be made at the end of Semester IV, which include 20 marks CIA in Semesters I, II, and III each, and of 40 marks in Semester IV.)

Minimum one-month internship pertaining to learning for concept to practice/prototype or product development for start-up/mini and final semester project/skilling in the summer vacation/combination of semester break and summer vacation in industry/premier research institute/NGO, etc.

Semester-III									
CourseCode	Course	Contact Hrs/wk.			SEE Duration hrs	Maximum Marks			Credits
		T	Tu	P		CIA	SEE	Total	
		Part – I							
21ULCEN3	English III – Advanced English and Correspondence	3	-	-	3	40	60	100	3
	Part-I Total	3	0	0		40	60	100	3
Part-II									
21UMBCC301	Core6: Applied and Environmental Microbiology	4	-	-	3	30	70	100	4
21UMBCC302	Core7: Agricultural Microbiology	4	-		3	30	70	100	4
21UMBCC303	Core8: Bioinstrumentation Techniques	4	-		3	30	70	100	4
21UMBDC301	DSE 1: Sustainability and Conservation (Zoology-2)	3	-	-	3	30	70	100	3
21UMBCC304	Core practical – 3 – Applied and Analytical Microbiology	-	-	6	6	40	60	100	2
21UMBDC302	DSE 1: Practical Sustainability and Conservation (Zoology-2)	-	-	6	3	40	60	100	2
<No course code>	Core Enrichment – 1: Concept to Practice Course		1	-	-	20	Evaluation at the end of Semester – IV		
	Core Enrichment 2: Internship 1	-	-	-		100		100	1
	Part-II Total	15	1	12		300	400	700	20
Part-III: Ability Enhancement Courses									
	FS 3:Career Acceleration Programme (CAP)	-	2	-					Audit course
	Part-III Total	-	2	-		0	0	0	
	Total (Part-I to Part-III)	18	3	12	-	340	460	800	23
		33				800			

Semester– IV										
CourseCode	Course	Contact Hrs/wk.			SEEDu ration hrs	Maximum Marks			Credits	
		T	T u	P		CIA	SEE	Total		
Part – I										
21ULCEN4	English IV –	3	-	-	3	40	60	100	3	
	Part-I Total	3	0	0		40	60	100	3	
Part–II										
21UMBCC401	Core 9: (Ad) Bacterial Metabolism	4	-	-	3	30	70	100	4	
21UMBCC402	Core10: (Ap) Industrial Microbiology	4	-		3	30	70	100	4	
21UMBCE401/ 21UMBCE402	Core Elective:1 Quality Assurance and Quality Control / Mycology and Virology	4	-		3	30	70	100	4	
	TDE 1:	2	-	-	3	Total Internal Evaluation			2	
						30	70	100		
	DSE:	3	-	-	3	30	70	100	3	
21UMBCC403	Core Practical – 4 – Fermentation Microbiology			6	6	40	60	100	3	
21UMBCE403/ 21UMBCE404	Core Elective Practical: Quality Assurance and Quality control / Mycology and Virology			4	3	40	60	100	2	
	DSE:Practical:			6	3	40	60	100	2	
	Core Enrichment – 1: Concept to Practice Course		1	-	-	40	-	100	-	
	Core Enrichment 2: Internship 2	-	-	-		100		100	1	
	Part-II Total	17	1	18		270	530	800	24	
Part-III:Ability Enhancement Courses										
<no subject code>	FS 3: Career Acceleration Programme (CAP)	-	2	-					Audit course	
	Part-III Total	0	2	0						
	Total (Part-I to Part-III)	20	3	18	-	310	590	900	27	
		37				900				

Minimum one-month internship pertaining to learning for concept to practice/prototype or product development for start-up/mini and final semester project/skilling in the summer vacation/combination of semester break and summer vacation in industry/premier research institute/NGO etc.

Trans-Disciplinary Elective & Discipline Specific Elective offered by Department to the Cluster for SEM-4 Students

Course Type	Course Code	Course title	Credit
Trans-Disciplinary Elective	21UMBTD401	Microbes in Human Welfare	2
Discipline Specific Elective	21UMBDE405/406	Pharmaceutical Microbiology – Theory/Practical	3/2

Semester– V									
Course Code	Course	Contact Hrs/wk.			SEE Duration hrs	Maximum Marks			Credits
		T	Tu	P		CIA	SEE	Total	
Part–II									
21UMBCC501	Core11: (Adv.) Immunology	4	-	-	3	30	70	100	4
21UMBCC502	Core12: (Adv/App) Molecular Biology and Genetic Engineering	4	-	-	3	30	70	100	4
21UMBCC503	Core 13: (Self-study) – (F/Ap)– Phycology	1	-	-	3	30	70	100	4
21UMBCC504	Core14: Concept Recapitulation Test (CRT) for Core Courses of Semester I to V – (F)	-	-	-	2	50	-	50	1
21UMBCE501/ 21UMBCE 502/ 21UMBCE 503	Core Elective 2: Fundamentals of Research Methodology/ Microbiology & Health care /Pharmaceutical Microbiology	4	-		3	30	70	100	4
	TDE 2:	2	-	-	3	100		100	2
21UMBCC505	Core Practical – 5 – Clinical and Molecular Microbiology	-	-	9	6	40	60	100	3
21UMBCE504/ 21UMBCE 505/ 21UMBCE 503	Core Elective Practical- 5 Fundamentals of Research Methodology/ Microbiology & Health care / Pharmaceutical Microbiology	-	-	4	3	20	30	50	2
	Core Enrichment 3: * Internship/Training	-	-	-		100	-	100	1
	Core Enrichment 4: Minor Project /Dissertation/Review Article/ Instrumental Training/ Industrial Tour Report	1/2		4/6		Evaluation in Semester – 6			
	Part-II Total	16/ 17		17/ 19		430	370	800	25
Part-III: Ability Enhancement Courses									
<no subject code>	FS-4 Community Engagement	-	2	-		Remarks			Audit course
	Part-III Total	0	2	-		0	0	0	

	Total (Part-II to Part-III)	16/ 17	2	17/ 19	-	430	370	800	25
		35/38				800			

Trans-Disciplinary Elective offered by Department to the Cluster for SEM– V Students

Course Type	Course Code	Course title	Credit
Trans-Disciplinary Elective	21UMBTD501	IPR, Copyright and Patenting	2

Semester–VI

NOTE:

Student are given option to choose from any ONE of the following combinations/schemes based on his/her choice for progression either in Research in the same/ allied field (**Scheme – A**) or in higher studies and/or placement (**Scheme – B**)

A. Core 15 + Core Enrichment-4 + Core Enrichment – 5

OR

B. Core – 15 + Core – 16 + Core – 17 + Core Practical + Core Enrichment - 4

The research in the form of Project / Start-up/Skill Training will be broadly based on the two verticals keeping in view the Local, National and Global needs: **Sustainable development / Health & Wellness.**

Semester–VI - SCHEME – A									
Course Code	Course	Contact Hrs/wk.			SEE Duration hrs	Maximum Marks			Credits
		T	Tu	P		CIA	SEE	Total	
Part–II									
21UMBCC601	Core15:(App) - Biostatistics and Bioinformatics	4	-	-	3	30	70	100	4
	Core Enrichment – 4 (Continue from Semester – V, Evaluated in Semester – 6)	-			-	100	-	100	4
	Core Enrichment 5: Project / Start-up/ Skill Training	2		24		***	***	300	14
		30						500	22
	Part-II Total							500	22
Total Marks:500									

Semester–VI - SCHEME –B									
Course Code	Course	Contact Hrs/wk.			SEE Duration hrs	Maximum Marks			Credits
		T	Tu	P		CIA	SEE	Total	
Part–II									
21UMBCC601	Core15:(App) - Biostatistics and Bioinformatics	4	-	-	3	30	70	100	4
21UMBCC602	Core16: (Adv) – Medical Microbiology	5	-	-	3	30	70	100	5
21UMBCC603	Core – 17: (App) – Forensic Microbiology	5	-	-	3	30	70	100	5
21UMBCC604	Core Practical – 6 – Medical and Forensic Microbiology	-	-	9	9*	40	60	100	4
	Core Enrichment – 4 (Continue from Semester – V, Evaluated in Semester – 6)	-			-	100	-	100	4
		23				230	270	500	22
	Part-II Total							550	22
Total Marks:500									

*6 hrs on Day – 1 and 3hrs on Day -2

Formation of Part-III

Course Code	Semester	Course / Component	Contact Hrs	No. of Courses	Credit/ Course	Total Credits
A. Ability Enhancement Course (AEC)						
(i) Ability Enhancement Compulsory Course (AECC)						
	I	AECCI: Introduction to SDG (online course)	-	1	Remarks	Audit Course
	I & II	AECC II: Environmental Conservation and Sustainable Development	1 Hr / Week / Semester	1	1+1	2
	I & II	AECC III: Human Values for Holistic Living	1 T + 2 Tu /Week /Semester	1	1+1+1	3
					Sub Total	5 + Audit course
(ii) Skill Enhancement Course (SEC)						
As per common list	Any Semester between II –V/VII	SEC-I *Value Added Courses	40 Hrs	1	1	1
	Any Semester between III – V/VII	SEC-II **Co-Curricular Course	80 to 120 Hrs	1	2	2
					Sub Total	3
B. Finishing School						
FS I to FS IV Compulsory to Earn Degree.						
	I	FS I: Student Induction Program	3 weeks Phase 1, Phase 2, Phase 3	-	Remark	Audit course
	Across I & II Semesters	FS II: Fundamentals of Design Thinking (Online/Offline)	40 to 60 Hrs	1	Remark	Audit course
	Semesters I to V / VII	FS III: Career Acceleration Programme – CAP (Placement	2 Hrs / Week /Semester	As per syllabus	Remarks	Audit course

		Training)				
	Semester V (3 yrs program) Semester VI (4 yrs program)	FS IV: Community Engagement	Twice a month	1	Remarks	Audit course
FS V to FS VIII Options for Advanced Learners						
	Any semester from II to V/VII	FS V: Indian & Foreign Languages	-	Any number of courses	Remarks	Audit course
	Any semester from II to V/VII	FS VI: Any number of Online course(s) from select MOOC platforms	-	Any number of courses	Remarks	Credit as per provider/audit course
	Any semester from III to V/VII	FS VII: Advanced Design Thinking	-	1	Remarks	Audit course
	Any semester from I to VI/VIII	FS VIII: #Extra Credit Course Any number of courses from any UG program across the College	Self-study	Any number of courses	As per course offered	As per credit(s) earned across all courses opted

***Value Added Courses** - Option to student to choose at least 1 from a list of courses offered by any department across the Institution.

****Co-Curricular Courses** - Option to students to choose 1 from a list of courses offered by any department across the Institution.

Student may opt for any course of the odd/even prevailing semester from any UG program across the Institution with the following guidelines:

- a. Attending class not mandatory.
- b. May be mentored by the course teacher.
- c. Preparation through self-study.
- d. CIA not mandatory; evaluated for total marks at the end of the semester.
- e. Indicates options to appear for the course through examination application and payment of examination fees of that course.
- f. Credits earned through each course indicated in the consolidated mark sheet as extra credits; not included for CGPA, percentage marks and classification.

TOTAL MARKS & CREDIT DISTRIBUTION TO EARN THE DEGREE

S. No	PART	Total Marks	Total Credits
1.	PART I: Language Course	400	12
2.	PART II: Core, IDC, DSE, TDE	4000	128
3.	PART III: AECC-I, II & III SEC- I & II FS I, II, III & IV	Remarks	08 + Credit audit
TOTAL		4400	148

VALUE ADDED COURSES (VAC) COURSES OFFERED BY THE DEPARTMENT

Sr. No.	Course Code	Course Title	Course Duration	Credits
1	21UMBVA01	Mushroom Cultivation	40 Hrs	1

CO-CURRICULAR COURSE (COC) COURSES OFFERED BY THE DEPARTMENT

Sr. No.	Course Code	Course Title	Course Duration	Credits
1	21UMBCOC1	Biofertilizer	80 Hrs	1

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE) OFFERED BY THE DEPARTMENT (SEM-4)

Sr. No.	Course Code	Course Title	Course Duration	Credits
1	21UMBDE405	Pharmaceutical Microbiology – Theory	50 hrs	3
2	21UMBDE406	Pharmaceutical Microbiology – Practical	6hr/week	2

TRANS DISCIPLINARY ELECTIVE (TDE) OFFERED BY THE DEPARTMENT

Semester	Course Code	Course Title	Course Duration	Credits
4	21UMBTDE1	Microbes in Human Welfare	40 hrs	2
5	21UMBTDE2	IPR, Copyright and Patenting	40 hrs	2

ENCLOSURE - II

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (AD)	Credits
21UMBCC501	Core 11: Immunology	4 Credits

Course Description:

Immunology is a branch of medicine and biology that covers the medical study of immune systems in all organisms. Immune system is responsible for fighting against the pathogens and protects the body from infection. This course is divided into five units, each discussing the different aspects of this system, from its basics to the advanced level. Starting with the overview of this system, the course gradually progresses to the finer aspects of the system and the mechanisms by which immune system functions to protect the body. The process of infection, dysfunction of immune system and the prophylaxis through vaccine is also discussed

Course objectives:

After successfully completing this course the student should be able to:

1. Demonstrate a comprehensive and practical understanding of basic immunological principles involved in protection mechanism.
2. Differentiate between innate and adaptive immunity, primary and secondary responses and identify the role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses.
3. Differentiate between humoral and cell mediated immunity.
4. Discuss Dysfunctional immunity and its consequences, Process of infection and vaccination
5. Application of Principle of various immune reactions in research and diagnosis

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K4)
CO ₁	Demonstrate a comprehensive and practical understanding of basic immunological principles involved in protection mechanism.	K3
CO ₂	Differentiate between innate and adaptive immunity, primary and secondary responses and identify the role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses.	K3& K4
CO ₃	Differentiate between humoral and cell mediated immunity.	K3
CO ₄	Discuss Dysfunctional immunity and its consequences, Process of infection and vaccination	K3
CO ₅	Application of Principle of various immune reactions in research and diagnosis	K4& K5

Course Content	Hours
Unit 1: Immunity and Immunogen	12hrs
<ul style="list-style-type: none"> • Types of immunity: Natural, Acquired, herd, Innate, specific • Cells and organs of immune system : An overview • Primary response and generation of memory • Antigen: Immunogenicity versus antigenicity, Factors influencing Immunogenicity, Adjuvant, Epitope and Haptens • Antigen processing and presentation (Endogenous and Exogenous Antigens) 	
Unit 2: Antibody	12hrs
<ul style="list-style-type: none"> • Antibody: Basic structure of Antibody • Immunoglobulin classes and their Biological activities • Epitope and Receptors on immunoglobulin molecule • Antibody Diversity and Clonal Selection Theory • Overview of Monoclonal Antibody 	
Unit 3: Dysfunctional Immunity	12hrs
<ul style="list-style-type: none"> • Immunodeficiency Diseases • Hypersensitivity • Autoimmune diseases • Overview of Tumor immunity • Overview of Transplantation immunity 	
Unit 4: Infection and Prophylaxis	12hrs
<ul style="list-style-type: none"> • Introduction to the normal flora of healthy human host • Host –microbe interactions: Process of Infection, Pathogenicity, Virulence and infection • Microbial adherence: Penetration of epithelial cell layers, Events in infection following penetration • Microbial virulence factors • Vaccines: Conventional and Modern 	
Unit - 5: Haematology and Serology	12hrs
<ul style="list-style-type: none"> • Study of Blood and Blood groups: Discovery of human blood group system • Principle, significance and procedure of blood transfusion, Blood coagulation • Serology - In vitro antigen: antibody reaction: Strength of antigen – antibody reaction: Antibody affinity and avidity • Precipitation and Agglutination Reactions: (in fluid and gel), immunoelectrophoresis, Haemagglutination, Bacterial Agglutination, Passive Agglutination and agglutination inhibition • Other reactions: Radioimmunoassay, ELISA, Western Blot, Immunofluorescence 	

Text Books:

- J.Kuby, R. A. Goldsby ,T.J.Kindt , B.A. Osborne (2013). Immunology 7thedition. W.H. Freeman and Company , New York (UNIT – 1,2.4,5)
- P.M. Lyolyard , A. Whelan, M.W. Fanger. (2011) Instant Notes in Immunology. 3rd edition. Garland Science Taylor and Francis Group, Newyork (UNIT-3)

Reference Books:

- C.A.Janeway, P.Travers, M. Walport, M.J. Shlomchick. (2005). Immunology – the immune system in health and Diseases. 6th edition. Garland Science Taylor and Francis Group, Newyork
- K.Murphy, P.Travers, M. Walport. (2008). Janeway’s Immunology. 7th edition. Garland Science Taylor and Francis Group, Newyork
- I.Roitt.(2017). Roitt’s Essential Immunology, 13th edition Blackwell Science
- J.M.Cruse, R.E.Lewis. (2009). Illustrated Dictionary of Immunology. 3rd edition. CRC Press Taylor and Francis Group, New York.
- A. K. Abbas, A. H.H.Lichtman, S.Pillai. (2017).Molecular and Cellular Immunity. 9th edition. Elsevier
- R. M. Atlas (2015). Principles of Microbiology. 2nd edition. Wm.C.Brown Publishers
- Prescott , Harley , Klein (2007). Microbiology 5th edition. McGraw-Hill Publishers

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

- <https://www.coursera.org/specializations/immunology>
- <https://www.my-mooc.com/en/mooc/fundamentals-immunology-part-1-ricex-bioc372-1x-1/>

Suggested MOOCs

- https://onlinecourses.swayam2.ac.in/cec20_bt05/preview
- <https://www.pasteur.fr/en/education/programs-and-courses/e-learning-mooc/mooc-innate-immunity-institut-pasteur>

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05

C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (AD / AP)	Credits
21UMBCC502	Core 12: Molecular Biology and Genetic Engineering	4 Credits

Course Description:

The present core course has been designed to cover all the essential aspects related to Molecular Biology field. It incorporates a brief overview of Nucleic acid, its salient features and models of DNA and RNA. It mainly focuses on the study of cell incorporating DNA Replication, Transcription and Translation in prokaryotic as well as eukaryotic organisms. It also emphasizes Post Transcriptional Modifications and Processing of Eukaryotic RNA. The course will also impart detailed explanation of Prokaryotic and Eukaryotic Transcriptional Regulation along with mechanism of Gene Silencing. During this course, the students will be imparted comprehensive understanding about key concept of DNA Repair Mechanisms. The application of the knowledge and the skill thus obtained in manipulating gene and constructing genetically modified organisms is also dealt with.

Course Objectives:

After completion of this course, student will be able to:

1. Understand the basics of human genetics and hereditary
2. Comprehend the mechanism of replication and recombination
3. Describe the process of transcription and translation in Prokaryotes
4. Develop knowledge of the biochemical basis of Mutation, Mutagenesis and repair
5. Understand and analyse the basic concept and scope of recombinant DNA technology, recognize its various tools, its applications, and ethical aspects of using RDT in developing products.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	CO Statement	Blooms taxonomy Level (K1 to K4)
CO1	Understanding of the basics of human genetics and hereditary	K2
CO2	Comprehension of the mechanism of replication and recombination	K3

CO3	Description of the process of transcription and translation in Prokaryotes	K4
CO4	Development of knowledge of the biochemical basis of Mutation, Mutagenesis and repair	K4
CO5	Understanding and analysing the basic concept and scope of recombinant DNA technology, recognize its various tools, its applications, and ethical aspects of using RDT in developing products.	K3/K4
Course Content		Hours
Unit: 1 Molecular genetics and organization of genetic materials		12 hrs.
<ul style="list-style-type: none"> • Concept of central dogma • DNA as genetic material: experimental evidences • Different forms of DNA • Genomic organization of Eubacteria and Archaeobacteria • Mendelian Laws 		
Unit: 2 Replication and Recombination		12 hrs.
<ul style="list-style-type: none"> • Experimental evidences of Replication and enzymes involved in DNA Replication • Process of Replication in Prokaryotes • Regulation of Replication • Process of Recombination- mechanism of gene transfer- Transformation, Conjugation, transduction • Transposable elements 		
Unit: 3 Gene Expression and Regulation		12 hrs.
<ul style="list-style-type: none"> • Prokaryotic Transcription: Machineries and Mechanism • Post transcriptional modifications of RNA: overview of splicing, capping, polyadenylation & editing • Genetic code, prokaryotic Translation (machineries and mechanism) and post translational modifications • An overview of Levels and modes of regulation of gene expression • The Operon Models: Regulation of lactose utilization – The lac operon & Regulation of tryptophan biosynthesis – The trp operon 		
Unit 4: Mutations and Repair		12 hrs.
<ul style="list-style-type: none"> • Occurrence, kinds of Mutation, spontaneous & induced Mutation • Mutagens, detection of Mutation Lethal Mutations, Biochemical Mutations • Phenotypic effects of Mutation and Molecular basis of Mutation • Significance & Practical applications of Mutation • DNA Repair-Types and mechanism 		

Unit 5: Genetic Engineering and rDNA Technology	12 hrs.
<ul style="list-style-type: none"> • Genetic engineering: aims and applications • Genetic manipulations of prokaryotes: <ol style="list-style-type: none"> a. Isolation of DNA b. Vectors of rDNA Technology – plasmid (pBR322 &pUC), Bacteriophage (lambda phage & M13), Cosmid, Phagemid, BACs, YACs c. Insertion of DNA molecules into a vector d. Transformation and Growth e. Detection of Recombinant molecules – Colony Hybridization • Genetic manipulations of eukaryotes: Genetic manipulation of plant cells (Agrobacterium mediated) and animal cells • Site directed mutagenesis • Molecular Chaperon 	

Text Books

- Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2014) Molecular Biology of the Gene, 7th edition, Cold Spring Harbour Lab. Press, Pearson Publication (UNIT-1-4)
- R.C.Dubey (2010) A textbook of Biotechnology, S. Chand and Company, New Delhi (UNIT-5)
- De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

Reference books

- Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
- Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
- Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
- Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
- Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2016) The World of the Cell, 9th edition, Pearson Benjamin Cummings Publishing, San Francisco
- S.B. Primrose, R.M. Twyman and R.W.Old.(2006) Principles of Gene Manipulation. 7th Edition, S.B.University Press,.
- B.D. Singh (2010) Biotechnology Expanding Horizons. Kalyani Publishers.
- Chatwal R.G., Anand, S.K. (2012). Instrumental Methods of Chemical Analysis. Mumbai: Himalaya publication
- Upadhyay, A., Upadhyay, K., Nath, N. (2009). Biophysical Chemistry: Principles and techniques. Mumbai: Himalaya publication

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Class Test

Suggested reading / E-resources

- <https://www.thermofisher.com/blog/ask-a-scientist/what-is-molecular-biology/>
- <https://plato.stanford.edu/entries/molecular-biology/>

Suggested MOOCs

- https://onlinecourses.swayam2.ac.in/cec20_ma13/preview

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (F/AD)	Credits
21UMBCC503	Core 13: Phycology (Self Study)	4 Credits

Course Description:

Phycology is the study of algae, which is a major category of microorganisms. Algae are photosynthetic organism found ubiquitously on the planet. This course discusses the general characteristics of algae, its distribution across various habitat and certain salient features which differentiates algae from other microbes. The course spans across five units, emphasizing the general features, distinguishing properties, thallus organization, occurrence, ultra-structure, reproduction pattern and economic importance of different classes of algae. Algal classification and its place in the microbial world is also discusses.

Course Objectives:

At the end of the course, the student will be able to:

1. Understand and appreciate general features of algae and their distribution;
2. Acquire a consolidated overview on different major groups of algae and algal classification
3. Evaluate the importance and functions of various organelles in the ultra-structure of algal cell
4. Comprehend the major differences among varied range of thallus organization and pigment systems
5. Recognize and appreciate the economic importance of different groups of algae

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	CO Statement	Blooms taxonomy Level (K1 to K4)
CO1	Understand the general features of algae and their distribution	K2
CO2	Acquire a consolidated overview on different major groups of algae and algal classification	K1/K2
CO3	Evaluate the importance and functions of various organelles in the ultra-structure of algal cell	K3
CO4	Comprehend the major differences among varied range of thallus organization and pigment systems	K3
CO5	Recognize and appreciate the economic importance of different groups of algae	K2/K3

Course Content	Hours
Unit 1:General account	12hrs
<ul style="list-style-type: none"> • General characteristics & distribution • Classification & range of thallus organization • Cell components & Pigment system • Motility & Mode of reproduction • Economic importance 	
Unit 2: Blue Green algae	12hrs
<ul style="list-style-type: none"> • General features & distribution • Major groups up to class • Range of vegetative structure • Cell structure & special features (heterocyst, hormogonia, Akinete) • Mode of reproduction & Economic importance 	
Unit 3: Diatoms	12hrs
<ul style="list-style-type: none"> • General characteristics • Distribution • Cell structure and its components • Motility and mode of reproduction • Economic importance of diatoms 	
Unit 4: Green algae	12hrs
<ul style="list-style-type: none"> • General characteristics & distribution • Classification & cell structure • Pigment system & motility • Mode of reproduction • Economic importance 	
Unit5:Brown& Red algae	12hrs
<ul style="list-style-type: none"> • General features • Major groups upto class • Cell structure and Pigment system • Mode of reproduction • Economic importance 	

Text Book:

- Sharma O.P. (2011). Textbook of Algae, 1st Edition, McGraw-Hill Education New Delhi (UNIT-1-5)

Reference Books:

- Dubey R.C. and Maheshwari, D.K. 2010. A Textbook of Microbiology • 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620
- Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (2002). Microbiology, 5th Edition, New Delhi; Tata Mc Graw Hill Publishing Co. Ltd.
- SundaraRajan S (2003). College Microbiology. Volume 1 & 2. Revised Edition, Vardhana Publications, Bangalore
- Prescott, L.M., J.P. Harley and D.A. Klein (2015). Microbiology, 7th Edition, W.M., C Brown Publishers.

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

- <https://www.coursera.org/learn/algae>
- <https://algaefoundationatec.org/>

Suggested MOOCs

- <https://www.mooc-list.com/tags/algae>
- <https://algaebiomass.org/blog/10195/introduction-algae-massive-open-online-course/>
- <https://advancedbiofuelsusa.info/the-algae-foundation-offers-three-massive-open-online-courses-moocs/>

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (App)	Credits
21UMBCE501	CE 1: Fundamentals of Research Methodology	4 Credits

Course Description:

Research methodology is a way of explaining how a researcher intends to carry out their research. It's a logical, systematic plan to resolve a research problem. A methodology details a researcher's approach to the research to ensure reliable, valid results that address their aims and objectives. This course discusses Research, its objectives, types, mechanism, process, analysis and the intricacies of thesis writing and data presentation in the form of posters and research publications.

Course Objectives:

After completion of this course, student will be able to:

1. Understand the concept of research and importance of studying research methodology
2. Gain knowledge regarding various components of research
3. Distinguish between various scientific documents
4. Understand the concept of thesis writing
5. Gain elementary knowledge regarding application of statistics in research

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	CO Statement	Blooms taxonomy Level (K1 to K4)
CO1	Understand the concept of research and importance of studying research methodology	K2
CO2	Gain knowledge regarding various components of research	K3
CO3	Distinguish between various scientific documents classes of fungi	K3/K4
CO4	Understand the concept of thesis writing	K3
CO5	Gain elementary knowledge regarding application of statistics in research	K3

Course Content	Hours
Unit 1: Introduction to Research Methodology	12hrs
<ul style="list-style-type: none"> • Introduction to Research and Research Methodology • Objective of Research • Types of research • Significance of research • Process of Research 	
Unit 2: Components of Research	12hrs
<ul style="list-style-type: none"> • Defining research problem • Designing research • Sample and sampling • Data Collection • Data Analysis 	
Unit 3: Scientific documents and standards	12hrs
<ul style="list-style-type: none"> • Scientific Documents: Types • Journals: types and properties. • Publication: Types, Ethics and standards • Quality of Journal: Impact Factor, Citation. • Google scholar 	
Unit 4: Dissertation/Thesis Writing and Presentation	12hrs
<ul style="list-style-type: none"> • Modes of presenting scientific data • Basics of Poster Presentation • Thesis/Dissertation writing: overview, components and order of presentation. • Ethics of Publication Thesis writing • Proposal writing 	
Unit 5: Elementary statistics for Research	12hrs
<ul style="list-style-type: none"> • Hypothesis and its types • Hypothesis testing • Measures of central tendency: Mean, Mode, Median • ANOVA • Chi Square test 	

Text Books:

- C.R. Kothari.(2004) Research Methodology. *2nd Edition*, New Age International Publisher. (UNIT-1-5)

Reference Book:

- Dr. Shanti Bhushan Mishra, Dr. Shashi Alok (2017), Handbook Of Research Methodology, 1st Edition, Publisher: Educreation- ISBN: 978-1-5457-0340-3
- Ranjit kumar (2011), Research Methodology – A step-by-step guide for the beginners, 3rd edition, SAGE Publications.

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

<https://gradcoach.com/what-is-research-methodology/>

Suggested MOOCs

<https://www.coursera.org/learn/research-methods>

<https://www.mooc-list.com/tags/research-methodology>

https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/330

https://onlinecourses.swayam2.ac.in/cec20_hs17/preview

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (App)	Credits
21UMBCE502	CE 2: Microbiology and Healthcare	4 Credits

Course Description:

Microorganisms play a very important role in our day to day life, especially in maintaining the good health. These life forms are very important in causing as well as preventing the diseases. This course deals with the discussion of beneficial roles of microorganisms in maintaining human health. Microorganisms as food, in preparation of food, in food spoilage, in protecting plant health with biopesticides and enhancing the growth with biofertilizers, and the super savior role as vaccine.

Course Objectives:

After completion of this course, student will be able to:

1. Understand the historical development of microbiology and the establishment of role of microbes in human health
2. Appreciate the beneficial role of microorganisms in Gut health and the importance of Probiotics
3. Recognize the role of microorganisms in and as food as well as in food spoilage
4. Evaluate the role of microorganisms in plant health
5. Understand the types and benefits of vaccines.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K4)
CO1	Understand the historical development of microbiology and the establishment of role of microbes in human health	K2
CO2	Appreciate the beneficial role of microorganisms in Gut health and the importance of Probiotics	K3
CO3	Recognize the role of microorganisms in and as food as well as in food spoilage	K3/K4
CO4	Evaluate the role of microorganisms in plant health	K3
CO5	Understand the types and benefits of vaccines.	K3

Course Content	Hours
Unit 1: History of Microbiology	12hrs
<ul style="list-style-type: none"> • History of microbiology and Health care • Spontaneous generation verses Bio-generation • Germ theory of disease • Koch Postulate • Antibiotics 	
Unit 2: Microorganisms as Probiotics	12hrs
<ul style="list-style-type: none"> • Probiotics • Characteristics of probiotics • Commercially available probiotic products • Benefits of probiotic products • Prebiotics 	
Unit 3: Microorganisms as food	12hrs
<ul style="list-style-type: none"> • Microorganisms as a food source - Single cell protein • Mushroom as a complete food and Nutritional level of mushroom • Microorganisms in Dairy (Cheese, Yogurt, Buttermilk, Kefir) • Microorganisms in fermented food (Pickles, Sauerkraut, Silage, Sausage, Bread) • Functional Food 	
Unit 4: Microorganisms as Bio-fertilizer and Bio-pesticides	12hrs
<ul style="list-style-type: none"> • Definition of Biofertilizer, history and milestones • Types of Bio-fertilizer and mode of application • Definition of Biopesticide, history and milestones • Types of Bio-fertilizer and mode of application • Advantages and limitations of Biofertilizer and Biopesticide 	
Unit 5: Microorganisms as Vaccines	12hrs
<ul style="list-style-type: none"> • Definition and history of Vaccines and vaccination • Traditional Vaccines: Live, attenuates vaccines, inactivated vaccines, • New generation vaccines: Toxoid vaccines, Recombinant Vaccines, DNA Vaccines, sub unit vaccine • Production of Vaccines • Pros and cons of vaccination 	

Text book:

- Frazier .W.CWesthoff, D.C., (2003). Food Microbiology. 18th edition Tata McGraw-Hill Publication Company (UNIT-2,3)
- Subba Rao, N.S., (1999). Bio-fertilizers in Agriculture and Agro forestry. New Delhi:Oxford IBH (UNIT-4)

- Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (2003). Microbiology 5th Edition, Tata McGraw-Hill Publication Company (UNIT-1,5)

Reference book:

- Tortora, G.J., Funke, B.R., Case, C.L., (2004). Microbiology Introduction .Singapore: Pearson Education.
- Prescott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology 5th edition, New York: WCB Mc GrawHill publication

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

- <https://www.genome.gov/news/news-release/Microbes-in-us-and-their-role-in-human-health-and-disease>
- https://www.amnh.org/content/download/131242/2201977/file/human_microbiome_the_role_of_microbes_in_human_health_stepread1.pdf
- <https://www.longdom.org/open-access/role-of-microbes-in-human-health-36338.html>

Suggested MOOCs

- <https://www.wur.nl/en/education-programmes/moocs/show-moocs/nutrition-and-health-human-microbiome.htm>
- <https://www.my-mooc.com/en/mooc/nutrition-and-health-human-microbiome/>

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (AD)	Credits
21UMBCE503	CE - 3 -: Pharmaceutical Microbiology	4 Credits

Course Description:

Pharmaceutical industry depends largely on the microorganisms and microbial technology. It is a sector that requires active participation of a microbiologist, a chemist, a biochemist and a skilled technician to carryout production activity at large scale. This course is designed to give an insight into the operation of a pharmaceutical unit and the role of microorganism as well as a microbiologist in its smooth operation.

Course Objectives:

The course is designed with the objectives to give students

1. A better perception about the importance of pharmaceutical microbiology standards
2. Basic understanding about the role of microbial technology in industries
3. Skills necessary in pharmaceutical industry/laboratories/ Research institutes
4. An understanding about the standard operating procedures as per Pharmaceutical regulatory authorities

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	CO Statement	Blooms taxonomy Level (K1 to K4)
CO1	To get a better perception about the importance of pharmaceutical microbiology standards	K2
CO2	To have a basic understanding about the role of microbial technology in industries	K2
CO3	To acquire skills necessary in pharmaceutical industry/laboratories/ Research institutes	K3
CO4	To learn and apply the standard operating procedures as per Pharmaceutical regulatory authorities	K3

Course Content	Hours
Unit 1: Introduction to Pharmaceutical Industry	10 hrs
<ul style="list-style-type: none"> • Role of a microbiology in a pharmaceutical industry • Good Laboratory Practices (GLP) in pharmaceutical industry. • Microbiology Laboratory and standards in industry • Regulatory practices and policies: FDA and NGCMA. 	
Unit 2: Processes in Pharmaceutical Industry	10 hrs
<ul style="list-style-type: none"> • Good manufacturing practices and Good microbiology laboratory practices. • QA and QC in industry • Concepts of pharmaceuticals, biologics and biopharmaceuticals • Types of pharmaceutical microbiology laboratories: Sterile & Nonsterile • SOP, clean room, zones, microbial filters, media 	
Unit 3: Quality control: Microbiology Laboratory	10 hrs
<ul style="list-style-type: none"> • Microscopic techniques for particulate matter • Antimicrobial testing of pharmaceutical products • Microbial Limit test, Water analysis • Bacterial Endotoxin Testing (BET) • Environmental Monitoring 	
Unit 4: Microbial control in pharmaceutical industries	10 hrs
<ul style="list-style-type: none"> • Disinfection: Classification, mode of action, factors influencing disinfectants • Sterilization: Introduction, significance • Microbiological assessment of various pharmaceutical products • Fumigation, Growth Promotion test, Biological indicators, Chemical Indicators 	
Unit 5: Role of microbes in pharmaceutical formulations	10hrs
<ul style="list-style-type: none"> • Pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). • Drug formulations, Carriers and delivery systems, targeted drug delivery, • Application of microbial enzymes in pharmaceutical industry • Microbial production and spoilage of pharmaceutical products 	

Text Book

- S. P., Vyas, V. Dixit (2007) Pharmaceutical Biotechnology, CBS Publishers & Distributors New Delhi
- R. Bhatia, (2000). Quality Assurance in Microbiology. CBS publishers & distributors, New Delhi.
- S. H. Willing, M.M. Tuckerman, W. S. Hitchings IV.(2007). Good manufacturing practices for Pharmaceuticals. 2nd edition. Mercel Dekker NC New York

Reference Book

- Stephen P. D., Norman A. H., Sean P. G., Brendan F. G. (2011) Hugo & Russell Pharmaceutical Microbiology 8th Ed. Wiley-Blackwell Publishing house
- John S. Wolfson and David C. Hooper, (1989) Quinolone antimicrobial agents. American Society for Microbiology, Washington.
- Cooper M. S. (1972) Quality control in the Pharmaceutical Industry Vol.2 Academic Press Inc

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

- https://www.iptsalipur.org/wp-content/uploads/2020/08/BP303T_PMB_UNIT_I.pdf

Suggested MOOCs

- <https://www.mooc-list.com/tags/microbiology>
- <https://www.classcentral.com/tag/microbiology>

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title	Credits
21UMBCC504	Core Practical - 5: Clinical and Molecular Microbiology	9hrs/week - 3 Credits

Course objectives:

After completing this course, Students will be able to:

1. Collect blood samples and other clinical samples and perform various serological and hematological diagnostic tests
2. Understand the significance of blood count, various blood components and their analysis
3. Isolate genetic material from different types of cells
4. Quantify the nucleic acid material
5. Perform gene transfer in bacteria using various techniques
6. Perform mutation in bacteria

List of Practical:

1. Study of serological and haematological reactions
 - a. Agglutination (blood grouping, Serodiagnosis of enteric fever by Widal test)
 - b. Serodiagnosis of syphilis by RPR Test
 - c. Total count of RBC and WBC
 - d. Differential count of WBC
 - e. Haemoglobin estimation by Sahli's method
 - f. Bleeding time by filter paper technique and clotting time by capillary method
 - g. Erythrocyte Sedimentation Rate (ESR-demonstration)
2. Blood Chemistry
 - a. Blood sugar estimation by GOD / POD method
 - b. Blood urea by DAM method
 - c. Serum bilirubin estimation
 - d. Cholesterol estimation
 - e. Ouchterlony Double Diffusion (Demonstration)
3. Isolation of genomic DNA from bacteria
4. Isolation of plasmid DNA from bacteria
5. Agarose gel electrophoresis of isolated DNA
6. Isolation of RNA from yeast cells
7. Quantification of DNA and RNA by spectrophotometry
8. Determination of T_m value of DNA
9. Bacterial Transformation
10. Bacterial Conjugation
11. U.V induced mutagenesis
12. Plasmid curing by Acridine orange (Demonstration)

Reference Books:

1. Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
2. Jawetz, Melnick & Adelberg's: Medical Microbiology, 26th Edition, Mc Graw Hill Companies, a LANGE medical book.
3. Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications.
4. Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby
5. T.A.Brown, Genome-2, 2nd edition
6. Verma and Agrawal, Cell biology, Genetics, Molecular biology
7. Karp, cell and Molecular biology

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title	Credits
21UMBCE504	CE 1 Practical: Fundamentals of Research Methodology	6hrs/week 2 Credits

Course Objectives:

The student shall be able to:

1. Acquire skills related to the Research problem formation and research designing
2. Understand the importance of scientific writing
3. Identify the statistical methods most suitable for data analysis

List of Practical:

1. Writing research proposal
2. Protocol filling and submission
3. Making data analysis using statistics

Reference book:

1. C.R. Kothari.(2004) Research Methodology. *2nd Edition*, New Age International Publisher.

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (F)	Credits
21UMBCE505	CE 2 Practical: Microbiology and Healthcare	6 hrs/week 2 Credits

Course Objectives:

After completing this course, Students will be able to:

1. Isolate microorganisms from different material and can study them
2. Can predict on the quality of the material

List of Practicals

- 1 Isolation and identification of microorganisms from butter milk
- 2 Isolation and identification of Probiotics from commercially available probiotic food
- 3 Isolation of Nitrogen fixing bacteria from root nodules
- 4 Isolation of non- symbiotic bacteria from Rhizospheric soil
- 5 Isolation and identification of fungus from fermented food (Bread)

Reference book:

1. Tortora, G.J., Funke, B.R., Case, C.L., (2004). Microbiology Introduction. Singapore: Pearson Education.
2. Prescott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology 5th edition, New York: WCB Mc GrawHill publication

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (F)	Credits
21UMBCE506	CE-3: Practical: Pharmaceutical Microbiology	6 hrs/week 2 Credits

Course Objectives:

The student shall be able to:

1. Acquire skills to examine microbial load of pharmaceutical products
2. Understand the role of microbes in drugs
3. Identify different microbes associated with products, enumerate them and understand their role
4. Evaluate different parameters affecting pharmaceutical product quality.

List of Practical

1. Sterility testing by using *B. sterothermophilus* / *B. subtilis*.
2. Testing for microbial contamination. Microbial loads from syrups and suspensions
3. Determination of antimicrobial activity of chemical compounds (like phenol, resorcinol and formaldehydes) Comparison with standard products.
4. Microscopic analysis of sterile injectables and tablets
5. Quality assessment of pharmaceutical products with special reference to regulatory affairs as per the standard methods

Reference Books

1. R. Bhatia, (2000). Quality Assurance in Microbiology. CBS publishers & distributors, New Delhi.
2. S. H. Willing, M.M. Tuckerman, W. S. Hitchings IV.(2007). Good manufacturing practices for Pharmaceuticals. 2nd edition. Merceel Dekker NC New York

Syllabus – Semester – VI

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (Adv/App)	Credits
21UMBCC601	Core 15: Biostatistics and Bioinformatics	4 Credits

Course Description:

This course explores the meaning of Biostatistics. It introduces students to some basic terms like variable, continuous variable, discrete or discontinuous variables population, sample, histogram, frequency, classes, class interval and frequency distribution. Students will learn about the measures used in biostatistics, probability, hypothesis testing, correlation and regression. Use of computer have been included with basic use of programs such as MS Word, MS Excel and MS Powerpoint. Along with biostatistics, the course is designed to give students both a theoretical background and a working knowledge of the techniques employed in bioinformatics. Emphasis will be placed on biological sequence analysis and its applications.

Course objectives:

After successfully completing this course the student should be able to:

1. Apply statistics and informatics methods for the analysis of data generated in biomedical research.
2. Comprehend the application of Biostatistics through Practical examples covering both small-scale lab experiments and high throughput assays.
3. Understand the basics of computer software and its applications
4. Analyse the experimental data with the help of suitable bioinformatics tool
5. Database searching and retrieval of information for the research and academics

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K5)
CO ₁	Understand basic concepts of statistics and their importance.	K1, K2
CO ₂	Interpret results of commonly used statistical analyses in written summaries.	K2, K3
CO ₃	Create graphs using Statistics to communicate important information about data, and interpret these graphs.	K4, K5
CO ₄	Use computers for analysis of biological data	K3
CO ₅	Use of important biological databases, use tools to retrieve data, and compare the data of the biological macromolecules	K5

Course Content	Hours
Unit 1: Concepts of Biostatistics	12hrs
<ul style="list-style-type: none"> • Biostatistics, its basic terminologies and applications • Data Collection and presentation. • Sampling methods, Random and non-random sampling. • Frequency Distribution • Graphical Representation of Data 	
Unit 2: Measures of Biostatistics, Probability Distributions	12hrs
<ul style="list-style-type: none"> • Measures of central tendency Mean, median and mode. • Measures of dispersion- Range, variance, standard deviation, Coefficient of variance • Laws of Probability. • Normal Distribution, Binomial Distribution • Poisson distribution 	
Unit 3: Hypothesis Testing, Correlation and Regression Analysis	12hrs
<ul style="list-style-type: none"> • Types of hypothesis. • Student's t-test: paired and unpaired. • Analysis of variance. • Chi-square test • Correlation and Regression analysis. 	
Unit 4: Computer Science: Components and Application	12hrs
<ul style="list-style-type: none"> • Structure of computer: Components, peripherals, uses and types • The window screen and parts of window, the control panel • MS Office: MS Word, MS PowerPoint, MS Excel • Internet: History, Basic Concepts, Connection Types, Applications, Search Engines and E mail. • Database: Introduction, Types, File formats, 	
Unit 5: Bioinformatics	12hrs
<ul style="list-style-type: none"> • Introduction and importance of Bioinformatics • Primary and Secondary Biological databases, Structure databases, miscellaneous databases, Information retrieval from Biological database: ENTREZ, SRS and DBGET • Sequence Alignment: FASTA, BLAST and Gap penalties • Introduction to Drug discovery. • Chemi-informatics. 	

Text Books:

- Banerjee P.K. (2007) Introduction to Biostatistics: S Chand Publication, New Delhi, India (UNIT: 1 ,2,3)

- Attwood, T.K., Parry. D.J. (2001). Introduction to Bioinformatics: Benjamin Cummings (UNIT: 4 & 5)

Reference Books:

- Andreas, D. B., Ouellette, B.F.F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition: Wiley publication.
- Misener, S. (2000). Bioinformatics – Methods and Protocols: Humana Press.
- Westhead D.R., Parish J.H., Twyman, R.A. (2002). Instant notes in Bioinformatics. Taylor and Francis publications.

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

- <https://www.youtube.com/watch?v=e4mwlqCQrc>
- https://www.youtube.com/watch?v=w-uk-_TOgR0

Suggested MOOCs

- https://onlinecourses.swayam2.ac.in/cec23_bt10/preview
- 2. https://onlinecourses.swayam2.ac.in/cec23_bt02/preview

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – VI

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (Adv/App)	Credits
21UMBCC602	Core 16: Medical Microbiology	5 Credits

Course Description:

Medical microbiology, the large subset of microbiology that is applied to medicine, is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. In addition, this field of science studies various clinical applications of microbes for the improvement of health. This course of Medical Microbiology begins with a review of the immune system, focusing on the body's response to invading microorganisms. Bacteria are then covered, the general concepts of bacterial microbiology and then the major bacterial pathogens of humans. Subsequent units cover virology, mycology, and parasitology.

Course objectives:

After successfully completing this course the student should be able to:

1. Appreciate and understand the role of microorganisms in causing diseases.
2. Comprehend and explain epidemiology of the diseases.
3. Evaluate and analyse causes, treatment, pathogenicity of viruses, bacteria, fungi and parasites
4. Understand the control measures for the transmissible diseases
5. Apply the advanced methods for the diagnosis

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	CO Statement	Blooms taxonomy Level (K1 to K5)
CO ₁	Appreciate and understand the role of microorganisms in causing diseases.	K1, K2
CO ₂	Comprehend and explain epidemiology of the diseases.	K2, K3
CO ₃	Evaluate and analyse the causes, treatment, Pathogenicity of viruses, bacteria fungi and parasites	K4, K5
CO ₄	Understand the control measures for the transmissible diseases	K3
CO ₅	Apply the advanced methods for the diagnosis	K5

Course Content	Hours
Unit 1: Epidemiology and host –parasite relationship	12hrs
<ul style="list-style-type: none"> • Definitions: Signs, symptoms and syndrome of disease, stages of infectious diseases-incubation period, prodromal phase, Invasive phase, decline phase • Infection and their types • Bacteremia, septicemia, pyamia, toxemia and Viremia • Epidemic, Endemic, Pandemic, Zoonotic and Exotic • Dynamics of disease transmission: Causative or etiological agents, sources of reservoir of infection 	
Unit 2:Study of pathogenic organisms: Bacteria and Bacteria like organisms	12hrs
<p>Morphology, cultural characteristics, biochemical characteristics, serology, lab diagnosis and treatments of</p> <ul style="list-style-type: none"> • Enteric pathogens (<i>Shigella and Salmonella</i>) • Pyogenic organisms – Staphylococcus and Streptococcus • Mycobacterium tuberculosis and Mycobacterium leprae • Rickettsia • Chlamydia 	
Unit 3:Study of pathogenic organisms:	12hrs
<p>Morphology, cultural characteristics, serology & lab diagnosis of :</p> <ul style="list-style-type: none"> • Parasites : Plasmodium, Giardia and Entamoeba • Fungus : Candida and Aspergillus • Spirochetes – Treponema, Leptospira • Metazoan diseases – Ascariasis and Filariasis • Tuleremia. 	
Unit 4:Viral diseases and their diagnosis with treatments	12hrs
<p>Symptoms, diagnosis and treatments of:</p> <ul style="list-style-type: none"> • Hepatitis: Hepatitis A & B viruses • Influenza and Measles • Chicken Pox • Rabies 	

<ul style="list-style-type: none"> • AIDS and Ebola viruses 	
Unit 5: Advanced techniques	12hrs
<ul style="list-style-type: none"> • Chemotherapeutic and antimicrobial agents • Bioavailability of Drug • Collection, transport and preliminary processing of Clinical pathogens • Rapid methods of identification, Molecular methods of identification • Gene Therapy 	

Text Book

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Reference Book

-
-
-
-

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

- <https://iums.ac.ir/files/microb/files/Murray.pdf>
- <https://repository.poltekkes-kaltim.ac.id/id/eprint/1153/1/medical%20microbiology.pdf>

Suggested MOOCs

- https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/248
- <https://pll.harvard.edu/course/medical-microbiology?delta=0>
- <https://www.mooc-list.com/tags/microbiology>

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – VI

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title (App)	Credits
21UMBCC603	Core 17: Forensic Microbiology	5 Credits

Course Description:

Forensic science applies natural, physical, and social sciences to resolve legal matters. The term forensics has been attached to many different fields: economics, anthropology, dentistry, pathology, toxicology, entomology, psychology, accounting, engineering, and computer forensics. Forensic evidence is gathered, examined, evaluated, interpreted, and presented to make sense of an event and provide investigatory leads. This course discusses all these aspects and aims at providing in-depth knowledge and skill to the learner about the subject

Course objectives:

After successfully completing this course the student should be able to:

1. Understand the basics of forensic science
2. Get familiarize with the biological methods of crime investigation
3. Appreciate role of microbiology in forensic science
4. Apply principles and techniques of forensic science to solve legal cases.
5. Use advanced analytical methods in solving medico-legal cases.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	CO Statement	Blooms taxonomy Level (K1 to K5)
CO ₁	Understand the basics of forensic science	K1, K2
CO ₂	Get familiarize with the biological methods of crime investigation.	K2, K3
CO ₃	Appreciate role of microbiology in forensic science	K3, K4
CO ₄	Apply principles and techniques of forensic science to solve legal cases.	K3
CO ₅	Use advanced analytical methods in solving medico-legal cases.	K4

Course Content	Hours
Unit 1: Introduction to Forensic Science	12hrs
<ul style="list-style-type: none"> • Introduction and historical perspectives of Forensic Science • Basic Principles of Forensic Science • Approaches and considerations for forensic microbiology • Sampling methods • Medico-legal aspects of forensic sampling 	
Unit 2: General Methods of Microbiological Investigation	12hrs
<ul style="list-style-type: none"> • Role of metagenomic data in microbial forensic • Importance of molecular markers • Taxonomic profiling of microbes • Methods of culturing • Strategies for storage of microbes 	
Unit 3: Biological evidence:	12hrs
<ul style="list-style-type: none"> • Collection of blood, cerebrospinal fluid, tissue, urine and feces samples • Serological, biochemical and molecular tests and risk of infections • Bacterial translocations in humans • Effect of physiological conditions (temp., anaerobic etc.) after death on commensal bacteria. • Microbial impacts in postmortem toxicology and death time prediction 	
Unit 4: Microbial decomposition	12hrs
<ul style="list-style-type: none"> • Soil microbiology of decomposition • Freshwater and marine decomposition • Microbiology of nonhuman models of terrestrial decomposition • Microbiology of terrestrial human decomposition • Importance of postmortem interval for microbial investigation 	
Unit 5: Advanced Tools for Forensic Analysis	12hrs
<ul style="list-style-type: none"> • Comparison microscope, IBIS • AFIS, ESDA • XRF, EDXRF • Bioinformatics DNA sequencing and digital matching – NCBI • Future use of microorganism as physical evidence 	

Text Books:

- Carter, D. O., Tomberlin, J. K., Benbow, M. E., Metcalf J. L. Forensic Microbiology, Wiley Publication
- Curry, A. S Methods of Forensic Science Interscience, New York

Reference Book

- Chowdhury, S Forensic Biology B P R & D, Govt of India

- Richard Saferstein, Forensic Science Hand book; Prentice Hall

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

1. <https://www.sjsu.edu/people/mary.juno/courses/1066/s8/Intro.pdf>
2. <https://www.casdschools.org/site/handlers/filedownload.ashx?moduleinstanceid=7592&dataid=6762&FileName=01-IntroForensicLaw.pdf>

Suggested MOOCs

1. <https://www.my-mooc.com/en/mooc/ntufsc/>
2. <https://www.mooc-list.com/tags/forensic-science>

Methods of assessing the course outcomes

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	30	05
	Test 2	Units 3,4,5	3 hours	70	15
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					30

Syllabus – Semester – VI

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title	Credits
21UMBCC604	Core Practical - 6: Medical and Forensic Microbiology	9hrs/week - 3 Credits

Course objectives:

After completing this course, Students will be able to:

1. Collect blood samples and other clinical samples and perform various serological and hematological diagnostic tests
2. Understand the significance of blood count, various blood components and their analysis
7. Isolate genetic material from different types of cells
8. Quantify the nucleic acid material
9. Perform gene transfer in bacteria using various techniques
10. Perform mutation in bacteria

List of Practical:

1. Physical, Chemical and Microscopic examination of Clinical samples – urine, stool, pus, Sputum
2. Isolation, identification of following pathogens from clinical Samples: *E. coli*, *Salmonella spp.*, *Pseudomonas spp.*, *Proteus spp.*, *Shigella spp.*, *Staphylococcus spp.*, *Streptococcus spp.* (for identification use of keys as well as Bergey's Manual is recommended)
3. Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar, Glucose azide medium, Cetrimide agar, TSI agar
4. DNA Fingerprinting (possible follow up activity) - Students use provided images of DNA fingerprinting gels to determine paternity and to match a crime scene sample to a suspect. Can be used as a stand-alone lab, or a follow-up after the Gel Electrophoresis lab
5. Gel Electrophoresis with Food Color - Students pour their own gels, load the gels with food coloring solutions, run the gels, and analyze the results
6. Protein Identification Through Immunoassay - Students use an immunoassay to show how forensic scientists can determine if blood on a bumper is from a human or another animal
7. FTIR (Fourier-transform infrared spectroscopy)–
 - Fibers: identification of fibers and fabrics in a forensic analysis

- Liquid: students obtain spectra of several pure liquids and identify an unknown
- Adhesives: compare and identify adhesive tape and labels
- Plastics: analyse and identify plastics

Reference book

- Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
- Jawetz, Melnick & Adelberg's: Medical Microbiology, 26th Edition, Mc Graw Hill Companies, a LANGE medical book.
- Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications.
- Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby

ENCLOSURE - III

TRANS- DISCIPLINARY COURSE

Syllabus – Semester – V

Department: **Microbiology**

Programme: **B.Sc. Microbiology**

Course Code	Course Title	Credits
21UMBTD501	TDE - 2: IPR, Copyright and Patenting	2 Credits

Course Description:

Intellectual property rights are the rights given to persons over the creations of their minds. In India, there are 7 types of intellectual property rights, namely – copyright, trademarks, patents, geographical indications, plant varieties, industrial designs and semiconductor integrated circuit layout designs. This course emphasizes on the importance of IPR for the educator, inventor, innovator, creator and for the economic growth of a nation.

Course Objectives:

This course is aimed at

- Familiarizing learners with the nuances of Intellectual Property Rights (IPR) so as to help them integrate the IPR process in their research activities.
- To give the Students “hands- on –training” in literature, including patent search and documentation of research activities that would aid an IPR expert to draft, apply and prosecute IPR applications.
- Facilitate the students to explore career options in IPR, Copyright and Trademark

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K1 to K4)
CO1	Understand the features and importance of IPR	K2
CO2	Appreciate the types and features of different types of IP	K2
CO3	Evaluate the importance of Copyright and its features	K3
CO4	Critically justify the application and need of Patent	K3
CO5	Justify the importance of IPR in economic growth and scientific advancement	K3

Course Content	Hours
Unit 1: Introduction to Intellectual Property Rights	8 hrs
<ul style="list-style-type: none"> • What is IPR? • Concept of Intellectual Property • Kinds of Intellectual Property • Economic Importance of Intellectual Property 	
Unit 2: The International Scenario	8 hrs
<ul style="list-style-type: none"> • The International Convention for the protection of new varieties of plants • Outcome of Duncal’s Proposal – TRIPS – Brief account • Introduction to Patents • Patenting to Microbes 	
Unit 3: Patents in India	8 hrs
<ul style="list-style-type: none"> • Indian Patent Act – 1970 • Procedure for obtaining Patents • Protection of Genetic Resources • Introduction to Infringement, Infringer 	
Unit 4: Copyright and Trademark	8 hrs
<ul style="list-style-type: none"> • What is copyright and Trademark? • What is covered in copyright? • What are Related Rights? How they are different from Copyright? • Why to protect Copyright? 	
Unit 5: IPR in Science	8 hrs
<ul style="list-style-type: none"> • IPR and Ideation • IPR and Innovation • Product and IPR • Process and IPR • IPR and Biological material 	

Text Books

- T. M Murray and M.J. Mehlman, Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000
- AjitParulekar and Sarita D’ Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd , 2006
- B.L.Wadehra; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000
- P. Narayanan; Law of Copyright and Industrial Designs;Eastern law House, Delhi ,2010

Reference books

- S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents and Design. Legal Aspects of Technology Transfer: A Conspectus
- WIPO : WIPO Guide To Using Patent Information
- WIPO : Intellectual Property (IP) Audit
- WIPO : WIPO Patent Drafting Manual
- WIPO : The Value of Intellectual Property, Intangible Assets and Goodwill

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

Suggested reading / E-resources

- https://www.wto.org/english/tratop_e/trips_e/intell_e.htm
- <https://ipr.icegate.gov.in/IPR/homePage>

Suggested MOOCs

- <https://www.mooc-list.com/tags/intellectual-property>
- <https://www.mooc-list.com/tags/ipr>

Methods of assessing the course outcomes

Components of CIA: 100 marks

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1 st & 2 nd Units	1 ^{1/2} hours	20	20
	Test 2	Units 3,4,5	3 hours	70	70
B	Assignment-1	Any topic from the syllabus	By the end of 8 th week	20	05
C	Assignment-2	Any topic from the syllabus	Before 2 nd CIA	20	05
Grand Total					100

