SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcomes-based Curriculum Framework

(LOCF)

For

B.Sc. Microbiology

Undergraduate Programme

From

Academic year

2021-22

Vision & Mission

Mission:

Equip the student with knowledge and skills of their chosen vocation,

Inculcate values.

Provide them opportunities for all, round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Microbiology

Undergraduate and Post graduate

	Name	Designation	Institute/Industry
Head of the Department			
	Dr. Unnati Padalia	Chairperson	K. J. Somaiya College of Science and Commerce
Subject Experts nominated by the Vice-Chancellor			
1	(For PG) Dr. Krutika Desai	Associate Professor in Microbiology	Mithibai College, Mumbai.
2	(For UG) Dr. Shruti Samant	Associate Professor in Microbiology	Bhavans College, Mumbai.
Subject experts			
1	Dr. Vikrant Bhor	Scientist-D	ICMR-National Institute for Research in Reproductive Health (NIRRH)
2	Dr. Shamlan M.S. Reshamwala	Assistant Professor	Centre of Energy Biosciences, Institute of Chemical Technology-(ICT), Mumbai (Deemed to be University-MHRD-UGC)

Representative from Industry/corporate sector/allied area			
	Dr. Chandra Babu	Director, Operations US and APAC region	Pfizer Pharmaceutical
Meritorious Alumnus			
	Dr. Madhavi Londhe	Research Scientist,	Dr. Lal Path Lab, Mumbai
Faculty of the specialisation			
1	Mrs. Miriam Stewart	Associate Professor and Head, Department of Microbiology	St. Xavier's College, Mumbai. (Autonomous-Affiliated to University of Mumbai)
2	Mrs. Hemlatta Chakraborty	Associate Professor	K. J. Somaiya College of Science and Commerce
3	Dr. Lolly Jain	Vice-Principal, Associate Professor, Department of Microbiology	K. J. Somaiya College of Science and Commerce
4	Dr. Soniya Shetty	Assistant Professor	K. J. Somaiya College of Science and Commerce
5	Mr. Shabib Khan	Assistant Professor	K. J. Somaiya College of Science and Commerce

6	Dr. Rashmi Thakur	Assistant Professor	K. J. Somaiya College of Science and Commerce
7	Ms. Versha Peghwal	Assistant Professor	K. J. Somaiya College of Science and Commerce

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K. J. Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

Autonomous college carries a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This

ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty, supported by several hands have been our unique outstanding propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu
Principal

Acknowledgement

At the outset, I would like to thank our, Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all the young and vibrant colleagues in the Department of Microbiology for the long and arduous work they have put in during the compiling of the restructured syllabus.

Dr. Unnati Padalia
Chairperson
Board of Studies in Microbiology

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Preamble

Microbiology, to the common man, is the study of invisible mini wonders that only cause disease. In reality, the vast majority of microorganisms co-exist alongside us without causing any harm. On the contrary, many of them are required for our survival. Microbiology is a study of this microscopic world. It is a research oriented subject and plays a pivotal role in our daily lives.

Microbiology is an indispensable part of our routine life. We are associated with the diverse world of microorganisms and depend on the different products produced by them. Microbiome is essential for the functioning of human development and immunity. Along with this the presence of microorganisms in air, soil and water substantiates their environmental significance. Basically, Microbiology is the branch of science which deals with study of microorganisms with emphasis on their morphology, biochemistry and industrial applications in diverse fields. Microbial cell-based technologies enhance our quality of life by providing new solutions to problems in health, environment and energy sector.

The syllabi for the three-year undergraduate programme are designed to enable the students to understand and select an area of their interest to pursue further studies for post-graduation.

1. Introduction

The primary objective of this programme is to prepare the students keeping into consideration the vision and mission of our Institute, and contribute to the holistic development of all the under-graduate learners of Microbiology. The governing principle which has been adopted for the academic transactions is based on Learning Outcomes-based Curriculum Framework (LOCF).

Taking into cognizance the global prerequisites of employability, the institute envisages to provide a focused, outcome-based Microbiology syllabus at the undergraduate level. Efforts are taken to manoeuvre the academic journey towards excellence. The major emphasis is to make the teaching-learning process more learner-centric. The LOCF approach has been adopted to strengthen learner's experiences as they engage themselves in the programme of their choice. The under-graduate programme would not only prepare the learners for academia but also would equip them to apply the knowledge for employability.

The programme also states the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, ethical behaviour and also skills for employability. The programme prepares students for sustainability of their academic growth and lifelong learning.

B.Sc. Microbiology programme offers learners access to fundamental concepts in Microbiology and opens horizons to explore recent trends in the subject. There is substantial scope for inter-disciplinary collaborative research with other allied branches of Biology. The programme fosters scientific temperament among the

learners and enriches problem solving skills. It is designed to bring out the intellectual potential of the learner and also allow the learner to keep pace with the recent advances in Microbiology.

After introducing the basics of Microbiology in Semester I and Semester II, syllabus progresses to include the topics of Immunology, Genetics, Biochemistry, Virology, Taxonomy, Dairy and Food Microbiology, basic and advanced Instrumentation in Semester III and Semester IV.

Semester V and Semester VI while focusing on the depth and applications of the above topics will also include topics of Population genetics, Emerging infectious diseases, Bioinformatics, Advanced Virology and basic Nanotechnology.
As mentioned in the syllabus, all the three courses of theory & practical are compulsory to B.Sc. Microbiology students (Semester III and IV). Choice is offered between Module III and Module IV in Course III in both Semester III and Semester IV.

2. Learning Outcomes-based Curriculum Framework

This programme is designed to initiate holistic development of the learner and create interest amongst the learners to study Microbiology. There are core disciplinary papers that provide the fundamental knowledge in the discipline of Microbiology. Topics are meticulously arranged keeping into consideration the different cognitive levels of learning. As the programme progresses year-wise the emphasis is on strengthening the core knowledge and presenting different domains to apply the knowledge of Microbiology.

Curriculum consists of a synergistic combination of Core, Discipline Specific Electives and Skill Enhancement Courses. This enables a learner to be well versed with the different applications of Microbiology.

2.1 Nature and extent of B.Sc. Microbiology

The B.Sc. Microbiology programme is of three years duration. Each year is divided into two semesters. The total number of semesters are six. The teaching and learning in the B.Sc. Microbiology programme will involve theory classes (lectures) and practical.

The curriculum will be taught through formal lectures with the aid of power-point presentations, audio-visual tools and other teaching aids can be used as and when required. Wherever possible RBPT (Research based pedagogical tools) approach will be adopted to make the process of learning more learner-centric. ICT-based teaching-learning tools will be incorporated through which even the mundane aspects could be made more interesting and relevant.

2.2 Aim of Bachelor's degree Programme

Learner should be able to:

1. Demonstrate a coherent understanding of the subject of Microbiology, its associated different allied learning areas and applications, and its linkages with related disciplinary areas/subjects.
2. Apply the skills required for identifying problems/issues and obtaining their solutions.
3. Communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject.
4. Meet one's own learning needs, drawing on a range of current research and development work and professional materials.

The overall aims of bachelor's degree program in Microbiology are to:

1) Present the elementary information about different aspects of Microbiology to learners.
2) Enable the learners to use this information in Microbiology for a better society.
3) Create an enriching learning environment for the learners to inculcate a deep interest in learning Microbiology.
4) Facilitate choice-based student-centric learning system.
5) Empower the learners by developing their ability to use their knowledge and skills to handle the specific theoretical and applied problems in Microbiology.
6) Encourage the learners to pursue advanced studies related to Microbiology by creating a concrete base of the fundamental concepts.
7) Assist the learners to develop an array of generic skills which are helpful in creating employment and business opportunities.

The expected outcome is to provide the learners with a sense of interconnectedness among the various domains of Microbiology.

The intention is to enhance the analytical skills of the learners and enable them to think and analyse and develop good research-oriented perspective.

3. Graduate Attributes in Microbiology

Attributes expected from the graduates of B.Sc. Microbiology Programme are:

GA-1. ***Disciplinary knowledge:*** Sound knowledge of the fundamentals of Microbiology with emphasis on the knowledge of recent developments in the various fields of Microbiology.

GA-2. ***Scientific reasoning:*** Skill set in performing bacteriological techniques such as aseptic techniques, enumeration of bacteria, etc.

GA-3. ***Analytical reasoning:*** Ability to analyse, think, plan, execute and review experiments and experimental results.

GA-4. ***Research-related skills:*** Awareness about research planning and ethical considerations in all the fields.

GA-5. ***Self-directed learning:*** Entrepreneurial skills as an offshoot of interaction with several Industry experts.

GA-6. ***Communication Skills:*** Expertise in communication skills.

GA-7. ***Leadership readiness/qualities:*** Gained life skills such as team work, leadership, patience as a result of group project participation.

4. Qualification descriptors

Upon successful completion of the programme, the learners receive a B.Sc. degree in Microbiology. Microbiology graduates of this department are expected to acquire knowledge of different domains of Microbiology. They will be able to demonstrate practical skills and the ability to apply principles of Microbiology to obtain solutions to domain related problems. This will also establish a concrete base to pursue post-graduation and further research in Microbiology. Along with the basic prerequisites of the discipline the emphasis would also be to facilitate the holistic development of the learner. A synergistic blend of proper communication skills, inquisitiveness and consistent upgradation of the knowledge would open avenues for academic excellence and greater career heights too.

The list below provides a synoptic overview of possible career paths provided by an undergraduate training in Microbiology:

1. Research
2. QC and QA departments in pharmaceutical industries
3. Government or Private Food and Water Testing Laboratories
4. Medical Laboratory Technology
5. Food Packaging and Dairy Microbiology firms
6. Cosmetic industry, Fermentation Industries

Job Roles for B.Sc. Microbiology graduate:

After graduation, one can seek a professional career as:

1. A laboratory technician in an Instrumentation Laboratory
2. An officer in a Research Laboratory, Hospitals, Blood Banks and Public Health Sector

3. QC and QA manager in Pharmaceutical, Cosmetics, Fermentation and other industries as a technician in Food, Dairy, Water testing and Pathology Laboratory

Higher Education options for B.Sc. Microbiology graduate:

1. M.Sc. Microbiology by Papers or M.Sc. Microbiology by Research
2. M.Sc. in a specialized branch of biological sciences (Life Sciences, Environmental Science, Biochemistry, Biotechnology)
3. Ph.D. in Microbiology
4. MBA PG Diploma in Medical Laboratory Technology (PGDMLT) or any other relevant PG Diploma.

The learners who complete three years of full-time study of an undergraduate programme will be awarded a Bachelor's degree in Microbiology.

5. Programme Learning outcomes

After the successful completion of B.Sc. Microbiology programme, the learner will be able to:

PLO I: Implement the principles of Microbiology in day-to-day life.

PLO II: Apply the basic knowledge of Microbiology to diverse areas such as Genetics, Medical Microbiology, Immunology, Biochemistry, Molecular Biology, Cell-biology, Food and Industrial Microbiology and analytical techniques.

PLO III: Demonstrate competency in Microbiological practical skills.

PLO IV: Evaluate problems involving Microbiology and undertake remedial measures to solve them.

PLO V: Express his/her views on Microbiology related topics effectively through oral and written communication.

PLO VI: Plan a professional career to provide innovative solutions to challenging societal problems, along with peers.

PLO VII: Analyse, interpret and draw conclusions from data.

5.1 Course Mapping

6 Semester	PLO	I	II	III	IV	V	VI	VII
	Course							
I	CC I	√	√	√		√		√
	CC II	√	√	√		√		√
	AECC I FC*							
	SEC I STP I							
	SEC II BCE**							
II	CC I	√	√	√		√		√
	CC II	√	√	√		√		√
	AECC I FC*							
	SEC I STP2							
	SEC II ICHI***							
III	CC I	√	√	√	√	√		√
	CC II	√	√	√	√	√		√
	CC III	√	√	√	√	√		√
	AECC I FC*							
	SEC I STP3							
	SEC II ICH2***							
IV	CC I	√	√	√	√	√		√
	CC II	√	√	√	√	√		√

	CC III	√	√	√	√	√		√
	AECC I FC*							
	SEC I STP4							
	SEC II ICH3***							
V 6 units	CC I	√	√	√	√	√	√	√
	CC II	√	√	√	√	√	√	√
	CC III	√	√	√	√	√	√	√
	CC IV	√	√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√
	DSE IV	√	√	√	√	√	√	√
	AECC I EVS							
	SEC I	√	√	√	√	√	√	√
	SEC II	√	√	√	√	√	√	√
	SEC III	√	√	√	√	√	√	√
VI 6 units	CC I	√	√	√	√	√	√	√
	CC II	√	√	√	√	√	√	√
	CC III	√	√	√	√	√	√	√
	CC IV	√	√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√
	DSE IV	√	√	√	√	√	√	√
	AECC I EVS							
	SEC I	√	√	√	√	√	√	√
	SEC II	√	√	√	√	√	√	√
	SEC III	√	√	√	√	√	√	√
V 3 units	CC I	√	√	√	√	√	√	√
	CC II	√	√	√	√	√	√	√

	CC III	For details of these courses refer to the LOCF document of Biochemistry.						
	CC IV							
	DSE I							
	DSE II							
	DSE III							
	DSE IV							
	AECC I EVS							
	SEC I	√	√	√	√	√	√	√
	SEC II	√	√	√	√	√	√	√
	SEC III	√	√	√	√	√	√	√
VI 3 units	CC I	√	√	√	√	√	√	√
	CC II	√	√	√	√	√	√	√
	CC III	For details of these courses refer to the LOCF document of Biochemistry.						
	CC IV							
	DSE I							
	DSE II							
	DSE III							
	DSE IV							
	AECC I EVS							
	SEC I	√	√	√	√	√	√	√
	SEC II	√	√	√	√	√	√	√
	SEC III	√	√	√	√	√	√	√

* FC = Foundation Course

** BCE = Basic communication in English

*** ICH = Indian Cultural Heritage (Value Education)

6. Structure of B.Sc. Microbiology programme

The curriculum frame work is designed around the choice-based credit system (CBCS). The programme consists of three years and six semesters (two semesters per year). To acquire a degree in B.Sc. Microbiology a learner must study

1. Core Courses (CC):

a) A course which is required to be opted by a candidate as a core course.

b) There are eighteen Core courses (CC), two each, in semesters I and II; three each in semesters III and IV and four each in semesters V and VI (for 6 units).

c) Each Core Courses is compulsory.

d) Each CC is comprised of 2 credits for theory i. e. 30 hours; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.

e) The purpose of fixing core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standard with other universities/institutions.

f) The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular discipline.

2. Ability Enhancement Compulsory Courses (AECC)

a) There are six AECC courses. Student must take one Ability Enhancement Compulsory Courses (AECC) in semesters I-VI

b) The AECC courses offered are:

AECC 1- Foundation Course (2 credits) (Semester I-IV),

AECC 2-Environmental Science (2 credits) (Semester V and VI)

3. Skill Enhancement Course (SEC):

a) They are designed to provide skill-based knowledge and contain both lab/hands on training/field work.

b) The main purpose of these courses is to provide life skills in hands on mode to increase employability.

c) There are twelve skill enhancement courses offered. Each student is supposed to take two in each Sem I-IV (Sports Training Programme, Basic Communication in English and Indian Cultural Heritage) of 1 credit each. There are four discipline-related skill enhancement courses (SEC), two offered in each Semester V and Semester VI each of 2 credit. The student is supposed to choose one SEC in Semester V and VI.

4. Discipline Specific Elective Courses (DSE):

a) Elective courses offered under the main discipline subject of study.

b) There are eight discipline specific elective courses (DSE), four in each semesters V and VI. The student is supposed to choose two out of four in each semester V and VI.

c) Each DSE theory course is of 2 credits i.e. 30 hour; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.

d) Research Project is offered as an option for the student to choose in lieu of a regular DSE course.

5. Generic Elective Course (GE)

a) Students can opt for one interdisciplinary Generic Elective Course (GE) in each of the semester V and VI.

b) Generic elective courses are offered in cognate disciplines by different departments in the college.

c) Credits for these courses are granted as additional credits.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
Core Course (CC)				
1	I	CC I	21US1MBCC1BCM	Basic Concepts of Microbiology
2		CC II	21US1MBCC2APM	Applied Microbiology
3		CC P	21US1MBCCP	Based on CC I and CC II
4	II	CC I	21US2MBCC1FMI	Fundamentals of Microbiology
5		CC II	21US2MBCC2EIM	Introduction to Environmental and Industrial Microbiology
6		CCP	21US2MBCCP	Based on CC I and CC II
7	III	CC I	22US3MBCC1MDM	Medical Microbiology
8		CC II	22US3MBCC2GVT	Genetics, Virology and Taxonomy
9		CC III	22US3MBCC3BIN	Bioinstrumentation
10		CCP	22US3MBCCP	Based on CC I, CC II and CC III
11	IV	CC I	22US4MBCC1IMM	Immunology
12		CC II	22US4MBCC2CBC	Concepts in Biochemistry
13		CC III	22US4MBCC3IFM	Industrial and Food Microbiology
14		CCP	22US4MBCCP	Based on CC I, CC II and CC III

15	V	CC I	23US5MBCC1MGB	Branches of Genetics and Basic Molecular Biology
16		CC II	23US5 MBCC2MEM	Medical Microbiology and Immunology - I
17		CCP I	23US5MBCCPI	Based on CC I and CC II
18		CC III	23US5 MBCC3MBI	Microbial Biochemistry-I
19		CC IV	23US5MBCC4BTU	Bioprocess Technology-Upstream Processes
20		CC P II	23US5MBCCP2	Based on CC III and CC IV
21	VI	CC I	23US6MBCC1GMR	Mechanisms of Genetic Exchange, Mutation and Repair
22		CC II	23US6MBCC2MMI	Medical Microbiology and Immunology-II
23		CC P I	23US6MBCCPI	Based on CC I and CC II
24		CC III	23US6MBCC3MBC	Microbial Biochemistry-II
25		CC IV	23US6MBCC4BTD	Bioprocess Technology-Downstream Processing and Fermentations
26		CC P II	23US6MBCCP2	Based on CC III and CC IV
27	V 3 Units	CC I	23US5MBCC1MGB	Branches of Genetics and Basic Molecular Biology

28		CC II	23US5MBCC2MEM	Medical Microbiology and Immunology - I
29		CC P I	23US5MBCCPI	Based on CCI and CC II
30	VI 3 Units	CC I	23US6MBCCIGMR	Mechanisms of Genetic Exchange, Mutation and Repair
31		CC II	23US6MBCC2MMI	Medical Microbiology and Immunology-II
32		CC P I	23US6MBCCPI	Based on CCI and CC II
Discipline Specific Electives (DSE)				
1	V 6 units	DSE I	23US5MBDSIEMI	Environmental Microbiology
2		DSE II	23US5MBDS2PAB	Plant and Animal Biotechnology
3		DSE III	23US5MBDS3RCH	Research Project (Proposal and Literature Survey)
4		DSE IV	23US5MBDS4SWM	MOOC on SWAYAM
		DSE P	23US5MBDSP	Practical Based on DSE Courses
5	VI 6 units	DSE I	23US6MBDSIRDV	Recombinant DNA Technology and Advanced Virology
6		DSE II	23US6MBDS2AIM	Advances in Immunology and Medical Microbiology
7		DSE III	23US6MBDS3RCH	Research Project (Dissertation)
8		DSE IV	23US6MBDS4SWM	MOOC on SWAYAM

		DSE P	23US6MBDSP	Practical Based on DSE Courses
Skill Enhancement Courses (SEC)				
1	I	SEC I	21US1SE1STP1	Sports Training Program Level 1
2		SEC II	21US1SE2BCE	Basic Communication in English
3	II	SEC I	21US2SE1STP2	Sports Training Program Level 2
4		SEC II	21US2SE2ICH1	Indian cultural Heritage Level 1 (Value education)
5	III	SEC I	22US3SE1STP3	Sports Training Program Level 3
6		SEC II	22US3SE2ICH2	Indian cultural Heritage Level 2 (Value education)
7	IV	SEC I	22US4SE1STP4	Sports Training Program Level 4
8		SEC II	22US4SE2ICH3	Indian cultural Heritage Level 3
9	V [6 + 3] units	SEC I	23US5MBSE1FDM	Food and Dairy Microbiology
10		SEC II	23US5MBSE2BIN	Introduction to Bioinformatics
11		SEC III	23US5MBSE3CRP	Commercial Products from recombinant organisms
12	VI	SEC I	23US6MBSE1AMT	Advances in Microbial Techniques

13	[6 + 3] units	SEC II	23US6MBSE2BST	Basics concepts in Biostatistics
14		SEC III	23US6MBSE3BBT	Business in Biotechnology
Ability Enhancement Compulsory Course (AECC)				
1	I	AECC I	21US1AE1FOC	Foundation Course
2	II	AECC I	21US2AE1FOC	Foundation Course
3	III	AECC I	22US3AE1FOC	Foundation Course
4	IV	AECC I	22US4AE1FOC	Foundation Course
5	V [6 + 3] units	AECC I	23US5AE1EVS	Environmental Science
6	VI [6 + 3] units	AECC I	23US6AE1EVS	Environmental Science
7	VII [6 + 3] units	AECC I	23US6AE1EVS	Environmental Science

6.2 Credit distribution for B.Sc. Microbiology

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	CC I	Basic Concepts of Microbiology	2	1	3
	CC II	Applied Microbiology	2	1	3
	AECC I	Foundation Course	2		2

	SEC I	Sports Training Program Level I	1		1
	SEC II	Basic Communication in English	1		1
II	CC I	Fundamentals of Microbiology	2	1	3
	CC II	Introduction to Environmental and Industrial Microbiology	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Program Level II	1		1
	SEC II	Indian cultural Heritage Level I (value education)	1		1
III	CC I	Medical Microbiology	2	1	3
	CC II	Genetics, Virology and Taxonomy	2	1	3
	CC III	Bioinstrumentation	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Program Level III	1		1
	SEC II	Indian cultural Heritage Level II (value education)	1		1
IV	CC I	Immunology	2	1	3
	CC II	Concepts in Biochemistry	2	1	3
	CC III	Industrial and Food Microbiology	2	1	3

	AECC I	Foundation Course	2		2
	SEC I	Sports Training Program Level IV	1		1
	SEC II	Indian cultural Heritage Level III (value education)	1		1
V 6 Units	CC I	Branches of Genetics and Basic Molecular Biology	2	1	3
	CC II	Medical Microbiology and Immunology - I	2	1	3
	CC III	Microbial Biochemistry-I	2	1	3
	CC IV	Bioprocess Technology- Upstream Processes	2	1	3
	DSE I	Environmental Microbiology	2	1	3
	DSE II	Plant and Animal Biotechnology	2	1	3
	DSE III	Research Project (Proposal and Literature Survey)			3
	DSE IV	MOOC on SWAYAM			3
	AECC I	Environmental science	1		1
	SEC I/II/III	Food and Dairy Microbiology/ Introduction to Bioinformatics/ Commercial products from recombinant organisms	2		2

VI 6 units	CC I	Mechanisms of Genetic Exchange, Mutation and Repair	2	1	3
	CC II	Medical Microbiology and Immunology-II	2	1	3
	CC III	Microbial Biochemistry-II	2	1	3
	CC IV	Bioprocess Technology- Downstream Processing and Fermentations	2	1	3
	DSE I	Recombinant DNA Technology and Advanced Virology	2	1	3
	DSE II	Advances in Immunology and Medical Microbiology	2	1	3
	DSE III	Research Project (Dissertation)			3
	DSE IV	MOOC on SWAYAM			3
	AECC I	Environmental science	1		1
	SEC I/II/III	Advances in Microbial Techniques/ Basic concepts in Biostatistics/ Business in Biotechnology	2		2
V 3 Units	CC I	Branches of Genetics and Basic Molecular Biology	2	1	3
	CC II	Medical Microbiology and Immunology - I	2	1	3
	CC III	Biochemistry courses	2	1	3

	CC IV		2	1	3
	DSE I		2	1	3
	DSE II		2	1	3
	DSE III		2	1	3
	DSE IV		2	1	3
	AECC I	Environmental Science	1		1
	SEC I/II/III	Food and Dairy Microbiology/ Introduction to Bioinformatics/ Commercial products from recombinant organisms	2		2
VI 3 Units	CC I	Mechanisms of Genetic Exchange, Mutation and Repair	2	1	3
	CC II	Medical Microbiology and Immunology-II	2	1	3
	CC III	Biochemistry courses	2	1	3
	CC IV		2	1	3
	DSE I		2	1	3
	DSE II		2	1	3
	DSE III		2	1	3
	DSE IV		2	1	3
	AECC I	Environmental Science	1		1
	SEC I/II/III	Advances in Microbial Techniques/ Basic concepts	2		2

		in Biostatistics/ Business in Biotechnology			

6.3 Semester Schedule

Semester	Core Course number	Core Course (CC) title	Discipline Specific Electives (DSE)	Generic Elective Course (GE)	Skill Enhancement Course (SEC)	Ability Enhancement Compulsory Course (AECC)
I	CC I	Basic Concepts of Microbiology	-	-	I]Sports Training Program Level I 2]Basic Communication in English	Foundation Course
	CC II	Applied Microbiology	-	-		
II	CC I	Fundamentals of Microbiology	-	-	I]Sports Training Program Level II 2]Indian cultural Heritage Level I	Foundation Course
	CC II	Introduction to Environmental and Industrial Microbiology	-	-		

					(Value Education)	
III	CC I	Medical Microbiology	-	-	1] Sports Training Program Level III 2] Indian cultural Heritage Level II (Value Education)	Foundation Course
	CC II	Genetics, Virology and Taxonomy	-	-		
	CC III	Bioinstrumentation	-	-		
IV	CC I	Immunology	-	-	1] Sports Training Program Level IV 2] Indian cultural Heritage Level III (Value Education)	Foundation Course
	CC II	Concepts in Biochemistry	-	-		
	CC III	Industrial and Food Microbiology	-	-		
V 6 units	CC I	Branches of Genetics and Basic Molecular Biology	DSE I, II	GE	SEC I/II/III	Environmental Science

	CC II	Medical Microbiology and Immunology - I				
	CC III	Microbial Biochemistry-I				
	CC IV	Bioprocess Technology- Upstream Processes				
VI 6 units	CC I	Mechanisms of Genetic Exchange, Mutation and Repair	DSE I, II	GE	SEC I/II/III	Environmental Science
	CC II	Medical Microbiology and Immunology- II				
	CC III	Microbial Biochemistry- II				
	CC IV	Bioprocess Technology- Downstream				

		Processing and Fermentations				
V 3 units	CC I	Branches of Genetics and Basic Molecular Biology	Biochemistry courses	GE	SEC I/ II/III	Environmental Science
	CC II	Medical Microbiology and Immunology - I				
	CC III	Biochemistry courses				
	CC IV					
VI 3 units	CC I	Mechanisms of Genetic Exchange, Mutation and Repair	Biochemistry courses	GE	SEC I/ II/III	Environmental Science
	CC II	Medical Microbiology and Immunology- II				
	CC III	Biochemistry courses				
	CC IV					

6.4 Course Learning Objectives

The three-year undergraduate Microbiology programme is designed to familiarize students with significant developments in Microbiology. This also aims at providing right perspective to study and understand Microbiology.

The purpose is to present to the learners the enormous diversity in the world of microorganisms and sensitize them to the unique characteristics and applications of different types of microorganisms. The idea behind this is to enable students to develop analytical skills and critical thinking. Thus, the students are encouraged to think critically, analyse different perspectives and actively process the information obtained from the experiments. It is our attempt that students achieve this objective through systematic reading and class lectures and through feedback on their written work-assignments, project/research papers, presentations, discussions, debates, etc. Our intention is to enable students to formulate cogent arguments, presenting the necessary evidence to establish these, based on a training in Microbiology.

7. Detailed B.Sc. Microbiology Syllabus

F. Y. B.Sc. Syllabus with effect from the Academic year 2021–2022

Syllabus – F. Y. B.Sc. Microbiology

Course No.	Course Title	Course Code	Credits	Hr	Periods (50 min)	Module	Lectures per module (50 minutes)	Examination		
								Internal Marks	External Marks	Total Marks
SEMESTER I										
Core courses THEORY										
I	Basic Concepts of Microbiology	21USIMCCC1BCM	2	30	36	3	12	40	60	100
II	Applied Microbiology	21USIMBCC2APM	2	30	36	3	12	40	60	100
Core courses PRACTICAL										
		21USIMBP	2	75	90			40	60	100
SEMESTER II										
Core courses THEORY										
I	Fundamentals of Microbiology	21US2MBCC1FMI	2	30	36	3	12	40	60	100
II	Introduction to Environmental and Industrial Microbiology	21US2MBCC2EIM	2	30	36	3	12	40	60	100
Core courses PRACTICAL										

		21US2MBP	2	75	90			40	60	100

F.Y. B. Sc. (Microbiology) SEMESTER I

Core Course- I

COURSE TITLE: Basic Concepts of Microbiology

COURSE CODE: 21USIMBCCIBCM [CREDITS – 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. State the significant historical events in Microbiology. 2. Justify the role of biomolecules in a living cell. 3. Describe structure and function of parts of a prokaryotic cell. 4. Classify microorganisms on the basis of nutrition. 5. Evaluate the different methods and nutrient media for cultivation and isolation of microorganisms.

Module 1	Introduction to Microbiology and Chemical basis of life	[12L]

Learning Objectives:

The module is intended to:

1. State the significant events in the ancient, golden and modern age of Microbiology.
2. Recognize the applications of microorganisms.
3. List the properties of different chemical bonds in biomolecules.
4. Describe the structure and role of water, carbohydrates, lipids, amino acids and proteins.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Cite the contributions of different scientists and discoveries in Microbiology. 2. State the role of microorganisms in environment, medicine and industrial fields. 3. List the different types of chemical bonds in biomolecules. 4. Describe the structural attributes and significance of water, carbohydrates, lipids, amino acids and proteins.		
1.1	**History & Scope of Microbiology:**	[2L]
1.1.a.	**Brief History of Microbiology:** First observations Debate over spontaneous generation	
1.1.b.	**Golden age of Microbiology:** The Birth of Modern Chemotherapy	
1.1. c.	**Modern Developments in Microbiology:** 1. Microbes and human welfare (in brief) 2. Only names of few emerging infections and their causative agents.	
1.2	**Chemical basis of life:** Revision of basic chemical structure of an atom and different chemical bonds. **Types of chemical bonds and their relevance in biomolecules:** 1. Ionic 2. Covalent 3. Hydrogen	[1L]
1.3	**Definition, general characteristic & functions of biomolecules**	

1.3.a.	**Structure and Role of water:** Polar nature of water and its four characteristics	[1L]
1.3.b.	**Carbohydrates:** Description of structure and functions of: 1. Monosaccharides (Hexoses, pentoses) 2. Disaccharides (Lactose, Maltose, Sucrose) Polysaccharides (Function of: Glycogen, Cellulose, Dextran, Chitin and Starch) 3. Significance of sugar derivatives: Inulin, Pectin, Mannitol, Inositol, Gluconic acid	[2L]
1.3.c.	**Amino- acids and Proteins:** 1. 20 standard amino acids and their classification. 2. Basic stereochemistry Peptide bond and its features 3. Levels of structure of proteins: Brief description of: a) Primary structure b) Secondary structure c) Tertiary structure d) Quaternary structure	[3L]
1.3. d .	**Lipids:** Structure and function of": a) Simple lipids b) Complex lipids	[3L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.

- Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

Module 2	Prokaryotic Cell structure- functions	[12L]

Learning Objectives:

The module is intended to:

1. Describe the structure and function of different cellular organelles of a prokaryotic cell.
2. Draw and label parts of a typical prokaryotic cell.
3. Recognize the significance of cell-wall, plasma membrane in maintaining turgor pressure.
4. Describe the structure and role of bacterial endospores.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Describe the structure and function of different components of a prokaryotic cell.
2. Compare the significance of various internal and external cellular structures of bacteria

2.1	Morphology of Prokaryotic cells: Size, Shape and Arrangement	[1L]
2.2	Plasma Membrane: The Fluid Mosaic model, Functions	[2L]
2.3	Cytoplasmic matrix – Inclusion bodies- types and significance of each, Ribosomes	[2L]
2.4	Bacterial chromosome (Nucleoid)	[1L]

2.5	Cell wall structure: Peptidoglycan Structure, Gram-Positive and Gram-Negative Cell Walls, Lipopolysaccharide layer, Functions of the cell wall	[2L]
2.6	Components external to cell wall- capsule, slime layer, flagella, fimbriae and pili Tactic Responses (Definitions)	[3L]
2.7	Bacterial endospores – structure and significance, stages in endospore formation.	[1L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.
- Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.
- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Module 3	Microbial Nutrition, Cultivation and Isolation	[12L]

Learning Objectives:

The module is intended to:

1. Categorize the nutrients required for growth of microorganisms.
2. Describe the utilization of growth factors.
3. Tabulate different nutritional types of microorganisms.
4. Prescribe culture media required for growth of different microorganisms.
5. Evaluate different methods of isolating microorganisms

Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Describe Macronutrients and Micronutrients required for microbial growth. 2. Explain the utilization of different growth factors. 3. Present an outline in a tabulation to represent different nutritional types of microorganisms. 4. State different types of culture media, their features and significance. 5. Apply isolation methods to obtain a pure culture.		
3.1	**Nutritional requirements:** Macronutrients and Micronutrients	[1L]
3.2	**Utilization of Elements:** Nitrogen, Phosphorus and sulphur Growth Factors	[2L]
3.3	**Nutritional types of microorganisms:** **Characteristic features of:** **Photoautotrophs:** a) Photoorganoheterotrophs b) Photolithoautotrophs **Heterotrophs:** a) Chemoheterotrophs b) Chemo organoheterotrophs c) Chemo-lithoautotrophs d) Oligotrophs	[2L]
3.4	**Types of culture media with examples:** **Physical types of media:** Liquid, semi-solid and Solid media	[5L]

	Chemical types of media: Defined and complex media **Functional types of media:** General purpose media, Selective media, Differential media, Enriched media, Enrichment media, Transport media	
3.5	**Isolation of microorganisms & pure culture techniques:** 1. Isolation on solid media by streak plate methods- T-streak, Quadrant method 2. Viable count methods: a) Pour plate b) Spread plate	[2L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.
- Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.
- Industrial Microbiology (2000). L Casida. New Age International Publishers. New Delhi.
- Industrial Microbiology. (1984) A H Patel. MacMillan. New Delhi.
- Principles of Fermentation Technology. (1997) 2nd Edition. Stanbury P. F., Whitaker A. &Hall--S. J. Aditya Books Pvt. Ltd, New Delhi.
- Fermentation Microbiology and Biotechnology, (2012) E. L. Mansi,3rd Edition.

Question paper Template

F.Y. B. Sc. (Microbiology) SEMESTER I

Core Course- I

COURSE TITLE: Basic Concepts of Microbiology

COURSE CODE: 21USIMBCCIBCM [CREDITS – 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	04	12	04	06	04	-	30
II	4	12	00	10	4	-	30
III	4	6	6	10	4	-	30
Total marks per objective	12	30	10	26	12	-	90
% Weightage	13	33	11	30	13	-	100

F.Y. B. Sc. (MICROBIOLOGY) SEMESTER I

Course- II

COURSE TITLE: Applied Microbiology

COURSE CODE: 21USIMBCC2APM

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Apply the basic principles of Microscopy and staining to observe bacterial cells. 2. Cultivate yeasts, fungi, molds and algae at laboratory level. 3. Recognize the economic significance of yeasts, fungi, molds and algae. 4. Control the growth of microorganisms by applying an appropriate physical or a chemical method.

Module 1	Microscopy	[12L]

Learning Objectives:

The module is intended to

1. Define basic terms related to Microscopy.
2. Explore parts of Bright-field Microscope and their functions.
3. Describe the significance of Resolution and Numerical aperture.
4. State the principle and brief working of Phase-contrast Microscope and Differential Interference Contrast Microscope.
5. Describe basic concepts of staining

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Define the basic terms related to Microscopy.

2. Draw and label the parts of Bright-field Microscope. 3. Recognize the significance of Resolution and numerical aperture in Microscopy. 4. Describe principle and working of Phase-contrast Microscope and Differential Interference Contrast Microscope. 5. Apply the principles of staining in experiments to study cytology of a bacterial cell.		
1.1	**Basic terminology of Microscopy:** 1. Focal length 2. Refraction, Reflection and magnification 3. The Light Microscope: Components; their features and functions. 4. Descriptions of Resolution and numerical aperture	[5L]
1.2	**Introduction to principle and brief working of:** 1. Dark Field Microscope 2. Phase Contrast Microscope; 3. Differential interference contrast Microscope	[2L]
1.3	**Staining of Specimen:** 1. Fixation. 2. Dyes and simple staining. 3. Differential staining	[5L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.

- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Module 2	Eukaryotic Cell Structure and Function	[12L]

Learning Objectives:

The module is intended to:

1. Differentiate between prokaryotic and eukaryotic cells.
2. List the morphological characteristics of yeasts, fungi, molds and algae.
3. State the economic significance of yeasts, fungi, molds and algae.
4. Describe the cultivation of yeasts, fungi, molds and algae.
5. Obtain an introductory account of features of protozoa.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. List the morphological features of yeasts, fungi, molds and algae.
2. Compare and contrast between sexual and asexual methods of reproduction in fungi.
3. Explore the economic importance of yeasts, fungi, molds and algae.
4. Perform experiments to cultivate bacteria and fungi using suitable media at laboratory level.
5. Describe the characteristics of yeasts, fungi, molds, algae and protozoa.

2.1	Difference between Prokaryotes and Eukaryotes -Tabulation.	[1L]
2.2	Classification, Morphological characteristics, Cultivation, reproduction and economic significance of: a) Yeasts, fungi and Molds. b) Life cycle of *Saccharomyces cerevisiae, Schizosaccharomyces*and *Rhizopus stolonifer* Algae and life cycle of *Chlamydomonas*	[5L] [4L]

2.3	Introduction to Protozoa	[2L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Module 3	Control of Microorganisms	[12L]

Learning Objectives:

The module is intended to:

1. Define basic terminology related to antimicrobial techniques.
2. Explore physical and chemical methods of controlling microbial growth.
3. Evaluate the effectiveness of the antimicrobial agent.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Define the terms related to control of microbial growth.
2. Appreciate the importance of methods to control microbial growth.
3. Differentiate between the concepts of bacteriostatic and bactericidal agents.
4. Implement the different physical and chemical methods at laboratory level and domestic level to control microbial growth.
5. Evaluate the effectiveness of the antimicrobial agent by a suitable laboratory technique.

3.1	**Basic Terminology:** Definition; Conditions influencing the effectiveness of antimicrobial agents	[1L]
3.2	**Physical methods of microbial control. Mode of action of:**	[5L]

	1. Heat: Moist & dry 2. Low temperature 3. Filtration 4. High pressure 5. Radiation 6. Desiccation 7. Osmotic Pressure	
3.3	**Chemical methods of microbial control: Mode of action of** 1. Phenolics 2. Biguanides (Chlorhexidine) 3. Alcohols 4. Halogens 5. Heavy metals 6. Quaternary ammonium compounds 7. Surface active agents 8. Aldehydes 9. Sterilizing Gases 10. Peroxygens	[5L]
3.4	**Evaluation of Effectiveness of Chemical Antimicrobial Agents:** Phenol co-efficient	[1L]
3.5	Self-study/ Case study/ sanitization measures for control of pandemic.	

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.
- Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

Question paper Template

F.Y. B. Sc. (MICROBIOLOGY) SEMESTER I

Course- II

COURSE TITLE: Applied Microbiology

COURSE CODE: 21USIMBCC2APM

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	04	10	06	06	04	-	30
II	10	20	-	-	-	-	30
III	16	10	-	04	-	-	30
Total marks per objective	30	40	06	10	04	-	90
% Weightage	33	45	7	11	4	-	100

F. Y. B. Sc. (MICROBIOLOGY)

SEMESTER I - Practical

COURSE CODE: 21USIMBCCP Credit- 02

Learning Objectives:

The Practical is intended to

1. Demonstrate basic aseptic techniques in Microbiology.
2. Describe the primary safety measures to be adopted while working with different microorganisms.
3. Describe the principle and working of different instruments in a Microbiology laboratory.

Learning Outcomes:

After the successful completion of the practical, the learner will be able to:

1. Implement basic aseptic techniques in practical related to microbial cultures and their characterization.
2. Apply primary qualitative biochemical tests to detect the presence of a biomolecule.

Core Course I	Basic Concepts of Microbiology

Experiment Sr. No.	Title and Number of credits	Number of hours
1	Safety Precautions in a Microbiology laboratory and disposal of biological waste	02
2	Qualitative test for carbohydrates- Demonstration	2.5

3	Qualitative test for proteins and amino acids	2.5
4	Qualitative tests for Nucleic acids: DNA and RNA	2.5
5	Study of cell structures	
	Monochrome staining	2.5
	b) Negative staining	2.5
6	Preparation of culture media	
	Liquid media (Nutrient broth)	O2
	Solid media (Nutrient agar, Sabouraud's agar)	O2
	Preparation of slants, butts and plates	2.5
7.	Inoculation techniques and study of growth	
	a) Liquid medium (Nutrient broth)	O2
	b) Solid media –slants, butts and plates	O2
	c) Study of colony characteristics of bacteria on Nutrient agar	2.5
	d) Use of differential (MacConkey agar), selective (Salt Mannitol Agar) and enriched media (Superimposed Blood agar Demonstration)	2.5

Core Course II	Applied Microbiology

Experiment Sr. No.	Title and Number of credits	Number of hours
1	Care of Microscope.	O1
2	Study of Compound Light Microscope	2.5
3	Differential staining-Gram staining	2.5
4	Physical methods of control of microorganisms	2.5

	a) Heat: Autoclaving Fractional sterilization, dry heat	O1
	b) Bacteria Proof Filtration (Demonstration of membrane filtration)	2.5
	c) Effect of UV rays (Demonstration)	2.5
	d) Effect of Desiccation	O1
5	Evaluation of a disinfectant by paper disc diffusion method (Phenolics as a representative example)	O1
6	Effect of soap as a disinfectant	O2
7	Study of oligodynamic action	O1
	Effect of storage of water in copper vessel group experiment)	1.5
8	Cultivation of yeasts and molds	O2
	a) Cultivation on Sabourauds agar	O2
	b) Fungal wet mounts and study of morphological characteristics	2.5
9	Cultivation and Permanent slides of	2.5
	i) Blue-green algae	O2
	ii) Protozoa	2.5

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.
- Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.

- Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.
- Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.
- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.
- Outlines of Biochemistry, (2006) 5th Edition. Conn P. Stumpf G Bruening and R Doi. John Wiley and Sons. New York. 1995.
- Industrial Microbiology (2000). L Casida. New Age International Publishers. New Delhi.
- Industrial Microbiology. (1984) A H Patel. MacMillan. New Delhi.
- Principles of Fermentation Technology. (1997) 2nd Edition. Stanbury P. F., Whitaker A. &Hall--S. J. Aditya Books Pvt. Ltd, New Delhi.
- Fermentation Microbiology and Biotechnology, (2012) E. L. Mansi,3rd Edition.

F.Y. B. Sc. (MICROBIOLOGY) SEMESTER II

Course- I

COURSE TITLE: Fundamentals of Microbiology

COURSE CODE: 21US2MBCC1FMI

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Evaluate the effect of different physical and chemical parameters on the growth of microorganisms. 2. Recall the principle and working of advanced microscopic techniques.

3. Demonstrate cellular structures by specific staining methods.
4. Investigate the general characteristics and significance of viruses, *Rickettsia, Chlamydia*, Actinomycetes and Archaebacteria.

Module 1	Microbial Growth	[12L]

Learning Objectives:

The module is intended to:

1. Define the concept of microbial growth.
2. State basic growth kinetics.
3. Measure the growth of microorganisms.
4. Regulate the growth of microorganisms by controlling different environmental factors.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Determine the growth rate of microorganisms.
2. Analyse the microbial growth by direct and indirect methods.
3. Differentiate between viable and non-viable count methods.
4. Appreciate the influence of different environmental factors on growth.

1.1	**Basic growth terminology:** Definition of growth, Prokaryotic cell cycle, give mathematical formulas.	[1L]
1.2	**Growth curve and phases of growth:** Lag, Log, Stationary and Death phase (VBNC)	[1L]
1.3	**Measurement of growth:** 1. Direct microscopic count, Haemocytometer. 2. Measurement of cell mass; growth yield.	[5L]

	3. Turbidity measurements-Nephelometric and Spectrophotometric techniques	
1.4	**Synchronous culture** Helmstetter Cumming technique	[1L]
1.5	**Influence of environmental factors on growth:** pH Temperature Aeration	[4L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.
- Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.
- Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.
- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Module 2	Specialized Microscopy and Special staining methods	[12L]

Learning Objectives:

The module is intended to:

1. Cite different versions of Advanced Microscopy.
2. State the principle and describe working of Fluorescence microscopy, TEM and SEM.

3. Introduce the newer techniques such as Confocal Microscopy, Scanning Probe, Scanning Tunnelling and Atomic Force Microscopy techniques. 4. List the steps of specimen preparation for different microscopic methods. 5. State the principle and represent an outline of different staining methods for specific cellular structures.		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Compare and contrast between different advanced microscopic methods. 2. Recognize the significance of the newer techniques such as Confocal Microscopy, Scanning Probe, Scanning Tunnelling and Atomic Force Microscopy techniques. 3. Implement the steps of specimen preparation for different microscopic methods. 4. Incorporate the methods of staining of specific cellular structures to study cytology.		
2.1	**Principle and working of:** Fluorescence Microscope.	[1L]
2.2	**The Electron Microscope:** Transmission Electron Microscope-TEM Scanning Electron Microscope- SEM	[2L]
2.3	**Specimen Preparation** in: Transmission Electron Microscope-TEM Scanning Electron Microscope- SEM Negative Staining, shadowing with metals, Freeze etching	[3L]
2.4	**Newer techniques in Microscopy**: Principle and working of Confocal Microscopy Introduction to:	[2L]

	Scanning probe Microscopy (Examples-The Scanning Tunnelling Microscope, The Atomic Force Microscope)	
2.5	**Staining specific structures:** Cell-wall, Capsule, Endospore, Metachromatic and Lipid granules, Flagella, Spirochete.	[4L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.
- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Module 3	Study of Viruses, Rickettsia, Chlamydia, Actinomycetes and Archaebacteria	[12L]

Learning Objectives:

The module is intended to:

1. State the characteristics of structure of viruses.
2. Recognize the difference between lytic and lysogeny modes of viral life-cycles.
3. Describe the methods for cultivation of viruses.
4. List the general characteristics and significance of Rickettsia, Chlamydia, Actinomycetes and Archaebacteria.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Compare and contrast the structural features and growth characteristics of viruses with other life forms.

2. Differentiate between the concepts of lytic and lysogeny modes of viral life-cycle. 3. Describe the general characteristics and significance of Rickettsia and Chlamydia. 4. Explain the general characteristics of Actinomycetes with specific reference to their significance. 5. Discuss the general characteristics and habitats of Archaebacteria.		
3.1	**Viruses:** General characteristics and structure with emphasis on T even structure, medical significance of viruses (with special reference to Corona viruses) Viruses causing pandemic (only tabulation) Introduction to viral cultivation- animal viruses Lytic cycle-details, Lysogeny- definition Enumeration of phages	[7L]
3.2	**Rickettsia and Chlamydia:** General characteristics, diseases and vectors	[2L]
3.3	**Actinomycetes:** General Characteristics and Significance	[2L]
3.4	Introduction to Archaebacteria, Characteristics, examples	[1L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.
- Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.
- Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.

- Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.
- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.

Question paper Template

F.Y. B. Sc. (MICROBIOLOGY) SEMESTER II

Course- I

COURSE TITLE: Fundamentals of Microbiology

COURSE CODE: 21US2MBCC1FMI

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	10	06	04	-	-	30
II	04	10	06	06	04	-	30
III	04	10	06	06	04	-	30
Total marks per objective	18	30	18	16	08	-	90
% Weightage	20	33	20	18	09	-	100

F.Y. B. Sc. (MICROBIOLOGY) SEMESTER II

Course- II

COURSE TITLE: Introduction to Environmental and Industrial Microbiology

COURSE CODE: 21US2MBCC2EIM

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Evaluate the role of microorganisms in air and soil habitats. 2. Represent the methods for potable water quality analysis and treatment of wastewater. 3. Recall the basic design of a fermenter and the parts of a fermentation process. 4. Implement different methods for preservation of microorganisms.

Module 1	Microorganisms in Air and Soil	[12L]

Learning Objectives:

The module is intended to:

1. List and describe different techniques to enumerate microbes in air.
2. Describe the microenvironment of a soil.
3. Recognize different microbial interactions.
4. State the characteristics of different microbial associations with vascular plants.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Quantify the microbial content of air.
2. Differentiate between different microorganisms in soil.

3. Appreciate the ecological significance of different microbial interactions. 4. Describe the salient features of the associations of microbes with vascular plants.		
1.1	**Air Microbiology:** a) Types and significance of organisms b) Techniques to enumerate air microflora	[2L]
1.2	**Microorganisms in the Terrestrial environment.** Soil as an environment and its diversity Microorganisms in the soil environment	[2L]
1.3	**Types of Microbial interactions (concept and one example of each):** 1. Mutualism 2. Co-operation 3. Commensalism 4. predation 5. Parasitism 6. Amensalism 7. Competition Human Microbiome	[3L]
1.4	**Microbial association with vascular plants:** 1. Phyllosphere 2. Rhizosphere and Rhizoplane 3. Mycorrhizae 4. Fungal and bacterial endophytes 5. Root nodule formation by *Rhizobium*	[5L]

References:

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.

Module 2	Microbiology of potable water and wastewater	[12L]

Learning Objectives:

The module is intended to:

1. Describe the methods of treatment of potable water.
2. Analyse the bacteriological quality of water.
3. Evaluate the different methods of waste-water treatment.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Recall the methods of treatment of potable water.
2. Interpret the results for tests performed to evaluate the bacteriological quality of potable water.
3. Summarize the wastewater treatment methods.

2.1	**Classes of natural waters** Atmospheric waters, surface waters stored waters and ground waters	[1L]
2.2	**Microbiology of potable water supplies** a) Preventive treatment b) Filter plants i. Sedimentation ii. Filtration	[2L]

	iii. Disinfection	
2.3	**Bacteriological examination of potable water** a) Index organisms of fecal pollution (Coliform group, other index organisms, significance of index organisms) b) Routine bacteriological analysis i. Standard Place Count ii. Test for coliforms (Presumptive, confirmed and completed test) iii. Differentiation of fecal from non-fecal coliform groups iv. Membrane filter method	[5L]
2.4	**Wastewater treatment** a) Composition of sewage and microorganisms in sewage b) Treatment i. Physical or mechanical treatment ii. Biological stabilization of sewage (Aerobic and Anaerobic processes) iii. Chemical treatment (Chlorination) and final disposal	[3L]
2.5	Waterborne diseases (representation in a tabular form	[1L]

References:

- Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.

Module 3	Industrial Microbiology	[12L]
Learning Objectives: The module is intended to: 1. Describe different microbial products obtained from industrial productions. 2. Illustrate the steps of primary and secondary screening. 3. Sketch the basic design of a fermenter. 4. Elaborate the different methods of preservation of microorganisms.		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. State the significance of industrial processes and the different microbial industries based on products. 2. Recall the steps of primary and secondary screening. 3. Illustrate the components of a fermenter and their function. 4. Evaluate the different methods of preservation of microorganisms.		
3.1	**Types of microbial products** (Primary and secondary metabolites) **Industries based on Microbial products:** (Medical, agriculture, chemicals, Food and beverages, etc)	[1L]
3.2	**Prerequisites of an Industrial microbiological process:** Microorganism, Medium, Product	[1L]
3.3	**Parts of a typical fermentation Process:** Upstream processing, Fermentation Proper, Downstream Processing	[1L]
3.4	**Screening**: Primary and secondary screening	[3L]
3.5	**Basic Fermenter design:**	[3L]

	Criteria for designing the fermenter Fabrication materials for fermenters Components of a fermenter and their uses	
3.6	**Preservation of microorganisms:** Aim of preservation, Culture collection centres, Methods of preservation (Serial subculture, Mineral oil overlay, Storage under liquid Nitrogen, Lyophilisation, Soil stock method)	[3L]

References:

- Industrial Microbiology (2000). L Casida. New Age International Publishers. New Delhi.
- Industrial Microbiology. (1984) A H Patel. MacMillan. New Delhi.
- Principles of Fermentation Technology. (1997) 2nd Edition. Stanbury P. F., Whitaker A. & Hall--S. J. Aditya Books Pvt. Ltd, New Delhi.
- Fermentation Microbiology and Biotechnology, (2012) E. L. Mansi,3rd Edition.

Question paper Template

F.Y. B. Sc. (MICROBIOLOGY) SEMESTER II

Course- II

COURSE TITLE: Introduction to Environmental and Industrial Microbiology

COURSE CODE: 21US2MBCC2EIM

[CREDITS - 02].

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	04	10	06	06	04	-	30
II	04	10	06	06	04	-	30
III	-	04	10	10	06	-	30
Total marks per objective	08	24	22	22	14	-	90
% Weightage	09	27	24	24	16	-	100

F. Y. B. Sc. (MICROBIOLOGY)

SEMESTER I - Practical

COURSE CODE: 21US2MBCCP Credit- 02

Learning Objectives:

The Practical is intended to:

1. Demonstrate techniques for microbial growth and its measurement.
2. Present different special staining techniques.
3. Describe methods for water analysis.
4. Demonstrate enrichment and isolation of coliphage from sewage.
5. Describe different methods for preservation of cultures.

Learning Outcomes:

After the successful completion of the practical, the learner will be able to:

1. Implement different techniques to enumerate microbial growth.
2. Apply methods to evaluate the quality of water sample.
3. Compare different methods for preservation of cultures.

Core Course I	Fundamentals of Microbiology	
Experiment Sr. No.	Title	Number of hours
1	Special Staining techniques	
	a) Cell wall staining	2.5
	b) Capsule staining	2.5
	c) Metachromatic staining	2.5
	d) Staining of lipid granules	2.5
	e) Staining of Endospore	2.5

	f) Flagella staining, (Demonstration)	2.5
2	Study of motility (Hanging drop preparation)	2.5
3	Determination of optimum growth conditions	
	a) Temperature	O2
	b) pH	2.5
4	Measurement of microbial growth	2.5
	a) Preparation of opacity tubes and determination of cell count	O1
	b) Growth curve of *E. coli* and determination of generation time (group experiment)	O2
5	Enrichment and isolation of coliphage from sewage. (Demonstration)	2.5
Core Course II	Introduction to Environmental and Industrial Microbiology	
Experiment Sr. No.	**Title and Number of credits**	**Number of hours**
1	Study of air microflora and determination of sedimentation rate.	5
2	Isolation of antibiotic producer by crowded plate technique.	5
3	Winogradsky Column.	5
4	Bacteriological analysis of water	5
5	Preservation of microorganisms	
	a) Preservation by mineral oil overlay	5
	b) Preservation by soil stock method	2.5
	c) Preservation by Glycerol stock method	2.5
References:		

- Microbiology. (2001),5th Edition. Lansing M. Prescott, Harley and Klein. McGraw Hill Higher Education, New York.
- General Microbiology. (2007) 5th Edition, R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. Prentice Hall. New Jersey.
- Microbiology-An Introduction. (1998) 6th Edition. Tortora Funke and Case. Addison Weseley Longman Inc.
- Fundamentals of Microbiology. (1974) 9th Edition. M. Frobisher. W.B. Saunders Company.
- Fundamental Principles of Bacteriology. (1984) A.J. Salle. Tata McGraw-Hill Education.
- Microbiology. (2001) 5th Edition, Michael Pelczar. Tata Mc Graw hill Education.
- Outlines of Biochemistry, (2006) 5th Edition. Conn P. Stumpf G Bruening and R Doi. John Wiley and Sons. New York. 1995.
- Industrial Microbiology (2000). L Casida. New Age International Publishers. New Delhi.
- Industrial Microbiology. (1984) A H Patel. MacMillan. New Delhi.
- Principles of Fermentation Technology. (1997) 2nd Edition. Stanbury P. F., Whitaker A. &Hall--S. J. Aditya Books Pvt. Ltd, New Delhi.
- Fermentation Microbiology and Biotechnology, (2012) E. L. Mansi,3rd Edition.

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

I) The lectures (of fifty minutes duration) are delivered to whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. Power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate to develop a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Assessment (CIA) & Semester End Examination.
- The Semester End Examination shall be conducted by the College at the end of each semester.
- Semester End Examination (external) (60 M)- Duration: 2 hours Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30 M	20 M
2	II	30 M	20 M
3	III	30 M	20 M

For Course I and Course II each Internal Evaluation (40 M)

1. Continuous Evaluation 25 M
2. Workshop/Project/Industrial Visit/ Excursion/ Seminar/ Assignment/ Research paper review 15 M

or

1. Project (40 M)

Evaluation pattern: Practical

- Semester-end evaluation: 30 Marks practical examination for each Course at the end of semester.
- Continuous internal evaluation 20 marks as per the following rubrics

Semester I (ONLINE/OFFLINE MODE)

Semester I (ONLINE/OFFLINE MODE)

Category	Marks allotted (Practical I)	Marks allotted (Practical II)
Journal	05	05
Spots/Quiz	05	05
Any one experimental technique	10 PI: Monochrome/ Negative staining	10 PII: Fungal wet mounts
Total Marks	**20**	**20**

Semester II (ONLINE/OFFLINE MODE)

Semester II (ONLINE/OFFLINE MODE)

Category	Marks allotted (Practical I)	Marks allotted (Practical II)
Journal	05	05
Spots/Quiz	05	05
Any one experimental technique	10 PI: Growth Curve experiment	10 PII: Preservation of microorganisms
Total Marks	**20**	**20**

10. Program and Course Code Format

The program is coded according to the following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (21- year of implementation is 2021-22)
2. Third letter 'U' designates undergraduate.
3. Fourth letter 'S' designates Science discipline.
4. Letter 'MB' is for Microbiology discipline (MB- Microbiology).
   This forms the programme code 21USMB.
   For the further course codes programme code is amended as follows
5. To designate the semester, add the digit (1-6) after S in the programme code. (for example, 21US1MB- for semester I)
   For the further course codes, addition to the program code should be done as per the following instructions.
6. To represent core courses (CC) followed by course number digit (1/2/3/4) and three lettered codes representing the title of the course.
7. For Ability enhancement course code, (AE) alphabets followed by a digit (1/2) followed by 'FOC'- Foundation course, 'EVS'-Environmental science is used.
8. For Skill enhancement courses code (SE) followed by digits (1/2/3) followed by letters 'STP'-Sports training program, 'BCE'-Basic Communication in English 'ICH'-Indian cultural heritage, followed by digits (1/2/3) representing the levels are used. In case of subject related SEC, (SE) followed by digits (1/2/3) followed by a three lettered code representing the title of the course are used.
9. For Discipline specific elective course (DS) of Semester V and VI, (DS) followed by digits (1/2/3/4) followed by a three lettered code representing the title of the course are used.

10. 'P' followed by digit indicates practical course number. (practical course number will be added for semesters only where there are more than one course.