SOMAIYA VIDYAVIHAR
K J Somaiya College of Science & Commerce
Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcomes based Curriculum Framework

(LOCF)

For

F.Y.B.Sc. Microbiology

Undergraduate Programme

From

Academic year

2023-2024

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.

	Name	Designation	Institute/Industry
1	Dr. Lolly Jain	Chairperson	Head of the Department K. J. Somaiya College of Science and Commerce, Mumbai
Subject Experts nominated by the Vice-Chancellor			
1	Dr. Pramod Ghogare	Assistant Professor	Head Department of Microbiology, SIES College, Sion, Mumbai
Subject experts outside parent University			
1	Dr. Nilima Shivale	Assistant Professor	School of Biotechnology and Bioinformatics D. Y. Patil deemed to be University, Navi Mumbai
2	Dr. Pratibha Shah	Associate Professor	Department of Microbiology, K. C. College HSNC University, Mumbai
Other members of the same faculty			
1	Prof. Bela Nabar	Professor	Head. Department of Microbiology, C.H.M. College, Ulhasnagar, Thane
2	Prof. Savanta Raut	Professor	Head. Department of Microbiology, Bhavans College, Andheri, Mumbai

Representatives from industry/ corporate sector/ allied area

1	Dr. Vikrant Bhor	Scientist E and Head	Department of Molecular Immunology and Microbiology, ICMR
2	Dr. Dina Saroj	Principal Scientist	Advanced Enzyme Technologies Limited, Mumbai
Meritorious alumnus			
1	Dr. Meenal Dukhande	Associate Professor	Department. of Microbiology, G. N. Khalsa College, Matunga Mumbai
Faculty of the specialization			
1	Dr. Soniya Shetty	Associate Professor	Department of Microbiology, K. J. Somaiya College of Science and Commerce
2	Mr. Shabib Khan	Assistant Professor	Department of Microbiology, K. J. Somaiya College of Science and Commerce
3	Ms. Versha Peghwal	Assistant Professor	Department of Microbiology, K. J. Somaiya College of Science and Commerce
Experts from outside the College whenever special course of studies are to be formulated (Molecular Biology expert)			
1	Dr.Tejas Chirmade	Senior Research Associate III	Bioanalytical Team, US Vitamins, Govandi Mumbai

Invited Members			
1	Ms. Kiran Surve	Assistant Professor	Department of Microbiology, K. J. Somaiya College of Science and Commerce
2	Ms. Poonam Shinde	Assistant Professor	Department of Microbiology, K. J. Somaiya College of Science and Commerce
3	Ms. Tarannoom Khan	Assistant Professor	Department of Microbiology, K. J. Somaiya College of Science and Commerce
4	Ms. Pooja Nandi	Assistant Professor	Department of Microbiology, K. J. Somaiya College of Science and Commerce
5	Ms. Dhanashree Tambe	Assistant Professor	Department of Microbiology, 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. Lolly Jain,
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. 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 the 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.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme, establishing multidisciplinary education and research universities, pooled credit bank and creating a National research Foundation to promote and support research activities in various

fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to develop an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. Our focus is to involve young minds to participate, contribute and add value at each stage in the field of their study. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum in multiple folds.

The LOCF will certainly help teachers to envisage the outcome expected from the learners at the end of the programme. For students, it will be a guide which shows how this curriculum will help them acquire all the skills and knowledge which are essential in their personal and academic growth. Higher education qualifications such as Bachelor's Degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

1. Introduction

The B.Sc. Microbiology programme is developed by keeping in mind interest of learners to explore the field of Microbiology. The framework helps to maintain the standard of Microbiology degrees/programmes through periodic programme review within a broad framework of agreed/expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The B.Sc. programme is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of students learning levels.

This curriculum framework is developed on the principles of student centric learning pedagogy. The platform intends to empower graduates with the skills required for pursuing Microbiology-related careers, higher education in Microbiology and allied subjects.

Various graduate attributes are emphasised in this framework such as critical thinking, basic psychology, scientific reasoning, moral ethical reasoning, etc. While designing this framework, an important aspect considered was the measurable teaching-learning outcome to ensure employability of the graduates. Implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e-learning platforms are suggested through this framework. The framework also focuses on issues relevant to India and also of the rest of the world.

Every course is designed in such a way that students get decent exposure to each topic by keeping an equilibrium between these topics and thus creating interest to pursue further education in the field of Microbiology. It covers the basic concepts of Microbiology to establish a strong foundation of the subject and helps students to explore the subject more. 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 interdisciplinary 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 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 two courses of theory & practical are compulsory to B.Sc. Microbiology students (Semester I and II).

The practical sessions will help the students to gain sufficient skills in Microbiological analysis of infections, food substances, preparation of media, biochemistry of cell, viral assays, bioassays, etc. Students are also encouraged to improve their scientific writing skills through various assignments. The research-based project work in the curriculum ensures team building attitude within students and utilise every aspect of the team members in the success of any project. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever-changing needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for B.Sc. with Microbiology will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of B.Sc. Microbiology

Degree programme in Microbiology is designed to include cutting edge core topics from Genetics, Immunology, Molecular Biology, Biochemistry and industrial Microbiology in a perfect balance. The scope of individual topics varies with the nature of specific Microbiology branch. In our endeavour to improve the employability of graduates of Microbiology programme, the curriculum offers courses on Dairy Microbiology, Antimicrobial Chemotherapy and Agricultural Microbiology. The B.Sc. Microbiology programme is of three years duration. Each year is divided into two semesters. The total numbers of semester are six/eight. 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 and video tools and other teaching aids can be used as and when required. Wherever possible RBPT (Research based pedagogical tool) 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 Programme Education Objectives (PEOs)

The overall aims of bachelor's degree programme 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 creating a better society.
3. Create an enriching learning environment for the learners to inculcate a deep interest in applying Microbiology concepts to solve real-life problems.
4. Facilitate choice-based student-centric learning systems.
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. Provide the learners with a sense of interconnectedness among the various domains of Microbiology.
8. Enhance the analytical skills of the learners and enable them to think, analyze and develop a research-oriented perspective.
9. Assist the learners to develop an array of generic skills which are helpful in creating employment and business opportunities.

3. Graduate Attributes in Microbiology

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

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

GA-2. Scientific reasoning: Ability to analyze, interpret the quantitative/qualitative data; while performing bacteriological techniques

GA-3. Analytical reasoning: Draw valid conclusions from the experimental data.

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

GA-5. Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

GA-6. Communication Skills: Expertise in communication skills: personal, scientific and professional.

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

4. Qualification descriptors

Undergraduate degree programmes of either 3 or 4-year duration, with multiple entry and exit points and re-entry options, with appropriate certifications such as:

- A 'UG certificate' is awarded to students who opt to exit after completing 1 year (2 semesters) of study in the chosen fields of study with having secured 44 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.
- A 'UG diploma' is awarded to students who opt to exit after 2 years (4 semesters) of study with having secured 88 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.
- A Bachelor's degree is awarded after a 3-year (6 semesters) programme of study in major discipline with having secured 132 credits and minimum credit requirements as follows

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	48
2	Minor Stream Course	20
3	Discipline Specific Elective Course	06
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	20

10	Open Elective Course	10
Total		132

- After completing the requirements of three year Bachelor's degree, candidate who meet the minimum CGPA of 7.5 shall be allowed to continue studies in the fourth year of undergraduate program to pursue and complete Bachelor's degree with honours/research (subject to change).
- A 4-year Bachelor's degree (honours) is awarded after eight semesters programme of study with having secured 176 credits and minimum credit requirements as follows:

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	76
2	Minor Stream Course	24
3	Discipline Specific Elective Course	14
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	24
10	Open Elective Course	10
Total		176

- They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 176 credits, including

12 credits from a research project/dissertation, are awarded UG Degree with Research.

The 4-year bachelor's degree programme is considered a preferred option since it would provide the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.

Upon successful completion of the programme, students receive B.Sc. degree in the Microbiology. B.Sc. Microbiology graduates of this department are expected to demonstrate the extensive knowledge of various concepts of Microbiology and its application thus contributes in research, development, teaching, government and public sectors. This programme will establish a foundation for student to further pursue higher studies in Microbiology. The list below provides a synoptic overview of possible employment areas provided by an undergraduate training in Microbiology.

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

1. Academics
2. Research
3. QC and QA departments in pharmaceutical industries
4. Government or Private Food and Water Testing Laboratories
5. Medical Laboratory Technology
6. Food Packaging and Dairy Microbiology firms
7. Cosmetic industry
8. Fermentation Industries
9. Agrochemical Industry
10. Forensic science department
11. Agricultural industry
12. Clinical analyst and medical coding

Job Roles for B.Sc. Microbiology graduate:

After graduation one can seek a professional career as:

1. A 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
4. Project fellow
5. Entrepreneur
6. Civil services
7. Competitive exams

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 of study will be awarded a Bachelor's degree in Microbiology.

5. Programme Specific Outcomes (PSOs)

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

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

PSO 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.

PSO III: Demonstrate competency in Microbiological practical skills.

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

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

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

PSO VII: Analyse, interpret and draw conclusions from data

5.1 .Course Mapping

Semester	PSO / Course	I	II	III	IV	V	VI	VII
I	MJ I							
	MJ II							
	MN I	√	√		√	√		√
	MN II	√	√	√	√	√		√
	AEC I							
	AEC II							
	VEC							
	CC							
	OE							
II	MJ I							
	MJ II							
	MN I	√	√		√	√		√
	MN II	√	√	√	√	√		√
	AEC I							
	AEC II							
	VEC							
	IK							
	CC							
	OE							

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 UG having six semesters (two semesters per year) or four years UG (Honours) having eight semesters (two semesters per year). Credit Distribution for Eight Semester is as follows:

Semester	MJ	DSE	SEC	VSC	MN	AEC	VEC	IKS	CC	FP	INT/ APT	OE	Total
I	6	-	-	-	6	4	2	-	2	-	-	2	22
II	6	-	-	-	6	3	2	1	2	-	-	2	22
III	6	-	3	2	4	1	-	1	2	-	-	3	22
IV	6	-	3	2	4	-	-	-	2	2	-	3	22
V	12	-	-	-	-	-	-	-	-	2	8	-	22
VI	12	6	-	4	-	-	-	-	-	-	-	-	22

BSc with Honours – 22 credits in Sem VII and VIII

BSc with Research – 22 credits in Sem VII and VIII

To acquire a degree in B.Sc. Microbiology a learner must study

1. **Major Core Courses (MJ):**
   a. A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.
   b. Students may be allowed to change major within the broad discipline at the end of the second semester by giving him/her sufficient time to explore interdisciplinary courses during the first year.
   c. There are twenty four Major Core courses (MJ), two each, in semesters I to IV; and four each in semesters V to VIII.
   d. Each Major Core Course is compulsory.

e. Each Major Core Course from semester I to VI is comprised of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hour per week and 1 credit for practical of two hours per week in every semester.
f. Each Major Core Course from semester VII and VIII is comprised of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hour per week and 1.5 credits for practical of three hours per week in every semester.
g. The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standards with other universities/institutions.

2. Minor Stream Course (MN):

a. A course is chosen by a candidate from interdisciplinary stream as a minor course. Minor Stream course helps a student to gain a broader understanding beyond the major discipline.
b. Students who take a sufficient number of courses in interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.
c. Students may declare the choice of the minor stream course at the end of the second semester after exploring various courses.
d. There are two each Minor stream course (MN), in semesters I and II. This Minor stream is comprised of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hour per week and 1 credit of practical of two hours per week in every semester.
e. There is one each Minor stream course (MN) in semester III and IV. This Minor stream is comprised of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hour per week and 2 credits for practical of four hours per week in every semester.
f. Each Minor stream Course is compulsory.

3. Ability Enhancement Courses (AEC)

a. The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity.

b. Students are required to achieve competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills.

c. There are five AEC courses spread over three semesters (I to III).

d. Each student is supposed to take two AE in semester I - English language and Modern Indian language of 2 credits each.

e. There are two AEC in semester 2 - English language of two credits and Modern Indian language of 1 credit.

f. There is one AE in semester 3 - Modern Indian language of 1 credit.

4. Value Education Courses (VEC)

a. The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, sustainable development and living.

b. The VEC courses offered are:

VEC I- Environmental Science I (2 credits) (Semester I),

VEC II- Environmental Science II (2 credits) (Semester II).

5. **Co-Curricular courses (CC):**
   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 two CC each in semester I to III – NCC (compulsory 1 credit course) and Other one from Music/Sports training program/Yoga/ Study Circle
   d. There are three CC each in semester IV – NCC (compulsory 1 credit course), second one from Music/Sports training program/Yoga/ Study Circle of 1 credit and third one is Field project of 2 credits.

6. **Open Elective (OE)**
   a. They are designed to provide multidisciplinary education.
   b. Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester I and II of two credit each.
   c. Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester III and IV of three credit each.
   d. Open courses are offered in cognate disciplines by different departments in the college.

7. **Indian Knowledge System (IKS)**
   a. They are designed to recognize the rich heritage of ancient and eternal Indian knowledge and thought as a guiding principle.
   b. Students can opt for one General IKS in semester II – Indian cultural Heritage of one credit.
   c. There is one IKS based on major subject in semester III of 1 credit.

8. **Skill Enhancement Course (SEC)**
   a. They are designed to provide skill-based knowledge pertaining to the Major course to the learner.
   b. The main purpose of these courses is to provide life skills in hands-on mode to increase employability.
   c. There are two skill enhancement courses offered. Each student is supposed to take one SEC in each semester III and IV of 3 credits each (2 credit theory and 1 credit practical).

9. **Discipline Specific Elective Courses (DSE)**
   a. Elective courses are offered under the major course subject of study.
   b. There are two discipline specific elective courses (DSE), offered in semesters VI of 2 credits theory and 1 credit practical.
   c. There is one discipline specific elective course (DSE), offered in semesters VII and VIII each of 2 credits theory and 2 credits practical.
   d. There is one advance level disciplinary course – Research Methodology of 4 credits offered in semester VII.

10. **Vocational Skill Course (VSC)**
   a. Vocational courses are designed to provide practical, hands-on training, competencies, and proficiency to students, ultimately enhancing their skills and employability.
   b. These courses are tailored to prepare individuals for specific careers and industries.
   c. There are two VSC offered one each in semester III and IV, each one is of two credits.
   d. There is one VSC offered in semester VI of 4 credits.

II. On Job Training (OJT)

a. On Job training of 4 credits is offered in semester VIII to enhance the specific skills and competencies required for a particular job.
b. OJT bridges the gap between theory and practical application, promoting a deeper understanding of concepts.

Internship/ Apprenticeship has a prominent role in linking higher education with the requirements of industry and the world of work. Students are offered internship/ apprenticeship embedded degree program to fulfil the objective of improving employability and forming robust industry academia linkage.
Internship/Apprenticeship of 8 credits is offered in semester V.

Field based learning /project should will provide opportunities for students to understand the different socio-economic contexts. It aims at giving the students exposure to development related issues in rural and urban settings.

Two field projects each 2 credits are offered one in each semester IV and V.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
1	I	MJ I		Course from Chemistry
2		MJ II		Course from Chemistry
3		MJ P		Based on MJ I and MJ II
4		MN I	23USIMBMNIFMI	Fundamentals of Microbiology
5		MN II	23USIMBMN2BCM	Basic Concepts of Microbiology
6		MN P	23USIMBMNP	Based on MN I and MN II
7		AEC I		Communication in English Level I
8		AEC II		Modern Indian Language Level I (Hindi/Marathi)
9		VEC		Environmental Science I
10		CC I		NCC
11		CC II		Music/Yoga/Sports Training Program Level I/ Study Circle
12		OE		Social Media Advertising/ Introduction to Microeconomics
13	II	MJ I		Course from Chemistry

14		MJ II		Course from Chemistry
15		MJ P		Based on MJ I and MJ II
16		MN I	23US2MBMN1MDG	Microbial Diversity and Growth
17		MN II	23US2MBMN2AMI	Applied Microbiology
18		MN P	23US2MBMNP	Based on MJ I and MJ II
19		AEC I		Communication in English Level II
20		AEC II		Modern Indian Language Level II (Hindi/Marathi)
21		VEC		Environmental Science - II
22		IK		Indian Cultural Heritage
23		CC I		NCC
24		CC II		Music/Yoga/Sports Training Program Level I/ Study Circle
25		OE		Indian Finance system and budget/ Brand Management

6.2 Credit distribution for B.Sc. Microbiology

Semester	Course number	Course title	Credits		
			Theory	ractical	Total
I	MJ I	Course from Chemistry	2	1	3
	MJ II	Course from Chemistry	2	1	3
	MN I	Fundamentals of Microbiology	2	1	3
	MN II	Basic Concepts of Microbiology	2	1	3
	AEC I	Communication in English Level I	2		2
	AEC II	Modern Indian Language Level I	2		2
	VEC	Environmental Science	2		2
	CC I		1		1
	CC II		1		1
	OE		2		2
	Total				22
II	MJ I	Course from Chemistry	2	1	3
	MJ II	Course from Chemistry	2	1	3
	MN I	Microbial Diversity and Growth	2	1	3
	MN II	Applied Microbiology	2	1	3
	AEC I	Communication in English Level II	2		2
	AEC II	Modern Indian Language Level II	1		1
	VEC	Environmental Science-II	2		2
	IKS	Indian Cultural Heritage	1		1

	CC I		1	-	1
	CC II		1		1
	OE		2	-	2
	Total				22

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	Minor Stream Courses (MN)	Ability Enhancement Courses (AEC)	Value Added Course (VEC)	Co-Curricular Course (CC)	Open Elective (OE)
I	I] MJ-I Course from Chemistry	I] MN-I Fundamentals of Microbiology	Communication in English Level I	Environmental Science I	NCC Music/Yoga /	Social Media Advertising/ Introduction

	2] MJ-II Course from Chemistry	2] MN-II Basic Concepts of Microbiology	Modern Indian Language Level I (Hindi/Marathi)		Sports Training Program Level I/ Study Circle	to microeconomics
II	1] MJ-I Course from Chemistry 2] MJ-II Course from Chemistry	1] MN-I Microbial diversity and growth 2] MN-II Applied Microbiology	Communication in English Level II Modern Indian Language Level 2 (Hindi/ Marathi)	Environmental Science - II	NCC Music/Yoga /Sports Training Program Level I/ Study Circle	Indian Finance system and budget/ Brand Management

6.4 Course Learning Objectives

The three-year undergraduate Microbiology programme is designed to familiarize students with significant developments in Microbiology. The objective of structured syllabus in Microbiology is to make the concepts and basics of Microbiology clear and interesting to students and also to ensure the development of vertical growth in the subject. The idea behind this is to enable students to develop analytical skills and critical thinking.

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 training in Microbiology.

7. Detailed B.Sc. Microbiology Syllabus

F. Y. B.Sc. Syllabus with effect from the Academic year 2023–2024

Syllabus – F. Y. B.Sc. Microbiology

Course Number	Course Title	Course Code	Credits	Periods	Module	Lecture/ Module	Examination

							Internal marks	External marks	Total Marks
SEMESTER I									
Minor Core courses THEORY									
I	Fundamentals of Microbiology	23USIMBMNIFMI	2	30	2	15	20	30	50
II	Basic Concepts of Microbiology	23USIMBMN2BCM	2	30	2	15	20	30	50
Minor Core Courses PRACTICAL									
		23USIMBMNP	2	60		-	CIA		50
SEMESTER II									
Minor Core courses THEORY									
I	Microbial diversity and growth	23US2MBMNIMDG	2	30	2	15	20	30	50
II	Applied Microbiology	23US2MBMN2AMI	2	30	2	15	20	30	50
Minor Core Courses PRACTICAL									
		23US2MBMNP	2	60			CIA		50

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

Minor Core Course- I

COURSE TITLE: Fundamentals of Microbiology

COURSE CODE: 23USIMBMNIFMI [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. Describe structure and function of parts of a prokaryotic cell.
3. Classify microorganisms on the basis of nutrition.
4. Evaluate the different methods and nutrient media for cultivation and isolation of microorganisms.
5. Implement the different methods for preservation of microbial cultures.

Module1	History of Microbiology and prokaryotic cell structure	[15L]

Learning Objectives:

1. To state the significant events in the ancient, golden and modern age of Microbiology.
2. To recognize the applications of microorganisms.
3. To describe the structure and function of different cellular organelles of a prokaryotic cell.
4. To draw and label parts of a typical prokaryotic cell.
5. To recognize the significance of cell-wall, plasma membrane in maintaining turgor pressure.
6. To describe the structure and role of bacterial endospores.

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

1.1	History & Scope of Microbiology	1 L
1.1. a.	Brief History of Microbiology: First observations Debate over spontaneous generation.	1 L
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 L

1.2	Morphology of Prokaryotic cells: Size, Shape and Arrangement	1 L
1.2.a	Plasma Membrane: The Fluid Mosaic model, Functions	2 L
1.2.b.	Cytoplasmic matrix–Inclusion bodies-types and significance of each, ribosomes	2 L
1.2.c.	Bacterial chromosome (Nucleoid)	1 L
1.2. d.	Cell wall structure: Peptidoglycan Structure, Gram-Positive and Gram-Negative Cell Walls, Lipopolysaccharide layer, Functions of the cell wall	2 L
1.3. e.	Components external to cell wall- capsule, slime layer, flagella, fimbriae and pili, Tactic Responses (Definitions)	3 L
1.2. f.	Bacterial endospores– structure and significance, stages in endospore formation.	1 L

References:

1. Tortora Funke and Case.(1998)Microbiology-AnIntroduction6thEdition. Addison Weseley Longman Inc.
2. Lansing M. Prescott, HarleyandKlein.2001.Microbiology.5thEdition. McGraw Hill Higher Education, New York.
3. R.Y.Stanier, J. Ingraham,M.WheelisandP.R.Painter.2007.General Microbiology. 5th Edition, Prentice Hall. New Jersey.
4. Michael Pelczar.2001.Microbiology.5thEdition.Tata McGrawhill Education.

Module 2	Nutrition, classification, isolation and preservation of microorganisms	[15L]

Learning Objectives:

1. To categorize the nutrients required for growth of microorganisms.
2. To describe the utilization of growth factors.
3. To tabulate the different nutritional types of microorganisms.
4. To describe culture media required for growth of different microorganisms.
5. To evaluate different methods of isolating and preserving 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 and their significance. 5. Apply isolation methods to obtain a pure culture. 6. Elaborate different methods of preserving microorganisms.		
2.1	Nutritional requirements: Macronutrients and Micronutrients	1 L
2.2	Utilization of Elements: Nitrogen, Phosphorus and sulphur Growth Factors	2 L
2.3	Nutritional types of microorganisms: a. Photoorganoheterotrophs b. Photolithoautotrophs c. Chemoheterotrophs d. Chemo organoheterotrophs e. Chemo-lithoautotrophs f. Oligotrophs	3 L
2.4	Types of culture media with examples: a. Physical types of media: Liquid, semi-solid and Solid media b. Chemical types of media: Defined and complex media c. Functional types of media: General purpose media, Selective Media, Differential media, Enriched media, Enrichment media, Transport media	4 L
2.5	Isolation of microorganisms &pure culture techniques: a. Isolation on solid media by streak plate methods- T-streak, Quadrant method b. Viable count methods: c. Pour plate d. Spread plate	2 L
2.6	Preservation of microorganisms: Aim of preservation, Culture collection centers, methods of preservation (Serial subculture, mineral oil overlay, storage under liquid nitrogen, lyophilization, soil stock method)	3L
References:		

1. Lansing M.Prescott, Harley and Klein.2001.Microbiology.5th Edition.McGraw Hill Higher Education, New York.
2. R.Y.Stanier, J.Ingraham, M.Wheelis and P.R.Painter.2007.General Microbiology. 5th Edition. Prentice Hall. New Jersey.
3. M.Frobisher.1974.Fundamentals of Microbiology. 9th Edition. W.B. Saunders Company.
4. AH Patel.1984.Industrial Microbiology. MacMillan. New Delhi.

Question paper Template

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

Minor Core Course- I

COURSE TITLE: Fundamentals of Microbiology

COURSE CODE: 23USIMBMNIFMI [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	6	6	3	3	3	-	21
II	3	6	6	3	3	-	21
Total marks per objective	9	12	9	6	6	-	42
% Weightage	21	30	21	14	14	-	100

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

Minor Core Course- II

COURSE TITLE: Basic concepts of Microbiology

COURSE CODE: 23USIMBMN2BCM [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. Control the growth of microorganisms by applying an appropriate physical or a chemical method.		
Module 1	**Microscopy**	**[15L]**
Learning Objectives: 1. To define basic terms related to Microscopy. 2. To explore parts of Bright-field Microscope and their functions. 3. To describe the significance of Resolution and Numerical aperture. 4. To state the principle and brief working of advanced microscopic techniques. 5. To 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 advanced microscopic techniques. 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	3 L

1.2	Introduction to principle and brief working of: 1. Dark field microscope 2. Phase contrast microscope 3. Differential interference contrast microscope 4. Fluorescence microscope 5. Transmission electron microscope- TEM 6. Scanning electron microscope- SEM	7 L
1.3	Staining of specimen: 1. Fixation 2. Dyes and simple staining 3. Differential staining 4. Special staining techniques (Cell wall, capsule, endospore, lipid granule, metachromatic granule staining, flagella, spirochetes)	5 L

References:

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

Module 2	Control of Microorganisms	[15 L]

Learning Objectives:

1. To explore physical and chemical methods of controlling microbial growth.
2. To 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. Justify the significance 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	2 L
3.2	Physical methods of microbial control. Mode of action of: 1. Heat: Moist & dry 2. Low temperature 3. Filtration 4. High pressure 5. Radiation 6. Desiccation 7. Osmotic Pressure	8 L
3.3	Chemical methods of microbial control: Mode of action of: 1. Phenolic 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	4 L
3.4.	Evaluation of effectiveness of chemical antimicrobial agents: phenol co-efficient	1 L
3.5	Self-study/case study/sanitization measures for control of pandemic. practical	
References:		

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

Question Paper Template

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

Minor Core Course- II

COURSE TITLE: Basic Concepts of Microbiology

COURSE CODE: 23US1MBMN2BCM [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	3	6	6	3	3	-	21
II	3	9	3	3	3	-	21
Total marks per objective	6	15	9	6	6	-	42
% Weightage	14	37	21	14	14	-	100

SEMESTER I - Practical

COURSE CODE: 23US1MBMNPCredit- 02

Course Learning Outcomes
After the successful completion of the practical, the learner will be able to: 1. Mention the primary safety measures to be adopted while working with different microorganisms. 2. Describe the principle and working of different instruments in a Microbiology laboratory. 3. Prepare and sterilize media for cultivation of microorganisms. 4. Apply aseptic techniques of media inoculation in Microbiology. 5. Cultivate microorganisms in controlled environment.
Learning Objectives: 1. To prepare nutrient media and cultivate microorganisms. 2. To understand the concept of sterility and use it in practicals wherever required 3. To evaluate different media with respect to their application. 4. To observe cell structures microscopically. 5. To interpret the effect of different sterilization methods on microorganisms. 6. To evaluate the different methods of preservation
Learning Outcomes: After the successful completion of the practical, the learner will be able to: 1. Use the sterilization concept for media preparation. 2. Evaluate use of different media as per the purpose of cultivating different microorganisms. 3. Explore the morphological features of a microbial cell microscopically. 4. Preserve cultures for short term and long term. 5. Interpret the effect of different sterilization methods on microbial control.

Practical Course		
Experiment Sr. No.	Title	Number of hours 60
	Minor Core Course I	
1	Introduction to the laboratory, safety precautions in a Microbiology laboratory and disposal of biological waste	03
2	Study of cell structures	
	a. Monochrome staining	02
	b. Negative staining	02
3	Preparation of culture media	
	a. Liquid media (Nutrient broth) b. Solid media (Nutrient agar)	03
4	Preparation of slants, butts and plates	02
5	Inoculation techniques and study of growth	
	a. Liquid medium (Nutrient broth)	02
	b. Solid media – slants, butts and plates	02
	c. Study of colony characteristics of bacteria on Nutrient agar	03
	d. Use of differential (MacConkey agar)	02
6	Preservation of microorganisms	
	a. Preservation by mineral oil overlay	05
	b. Preservation by soil stock method	03
	Minor Core Course II	
7	Care of Microscope	
8	Study of Compound Light Microscope	02
9	Differential staining – Gram staining	02

10	Special staining	
	a. Cell wall staining	02
	b. Lipid granule staining	02
	c. Endospore staining	02
11	Demonstration	
	a. Flagella staining	01
	b. Spirochete staining	01
12	Physical methods of control of microorganisms	
	a. Heat: Autoclaving Fractional sterilization, dry heat	03
	b. Bacteria Proof Filtration (Demonstration of membrane filtration)	03
	c. Effect of UV rays	04
	d. Effect of Desiccation	03
13	Evaluation of a disinfect and by paper disc diffusion method (Phenolic as a representative example)	04
14	Study of oligodynamic action	02

References:

1. Laboratory Manual in Microbiology by P.Gunasekaran, New Age International Publishers.
2. Laboratory manual in General Microbiology by N.Kannan, Palani Paramount publications.

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

Minor Core Course- I

COURSE TITLE: Microbial diversity and growth

COURSE CODE: 23US2MBMNIMDG [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the course, the learner will be able to: 1. Investigate the general characteristics and significance of diverse groups of microorganisms. 2. Evaluate the effect of different physical and chemical parameters on the growth of microorganisms.

Module 1	Study of Microbial Diversity	[15 L]
Learning Objectives: 1. To state the characteristics of structure of viruses. 2. To recognize the difference between lytic and lysogenic modes of viral life-cycles. 3. To describe the methods for cultivation of viruses. 4. To list the general characteristics and significance of diverse groups of microorganisms		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Explain the classification, morphological characteristics, cultivation and economic significance of yeasts, fungi molds and algae. 2. Compare and contrast the structural features and growth characteristics of viruses with other life forms. 3. Differentiate between the concepts of lytic and lysogenic modes of viral life-cycle. 4. Describe the general characteristics and significance of Rickettsia and Chlamydia. 5. Explain the general characteristics of Actinomycetes with specific reference to their significance. 6. Discuss the general characteristics and habitats of Archaebacteria.		
1.1	Classification, morphological characteristics, cultivation and economic significance of: Yeasts, fungi, molds and algae.	5 L

1.2	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, Lysogenic- definition Enumeration of phages	5 L
1.3	Rickettsia and Chlamydia: General characteristics, diseases and vectors	2 L
1.4	Actinomycetes: General Characteristics and Significance	2 L
1.5	Introduction to Archaebacteria, Characteristics, examples	1 L

References:

1. Lansing M.Prescott, Harley and Klein.2001.Microbiology.5th Edition. McGraw Hill Higher Education, New York.
2. R.Y.Stanier, J.Ingraham, M.Wheelis and P.R.Painter.2007.General Microbiology. 5th Edition. Prentice Hall. New Jersey.
3. Tortora Funke and Case.1998. Microbiology-An Introduction.6th Edition. Addison Weseley Longman Inc.
4. M.Frobisher.1974.Fundamentals of Microbiology. 9th Edition. W.B. Saunders Company.
5. A.J.Salle. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Education. Michael Pelczar.2001.Microbiology.5th Edition, Tata McGraw Hill Education.

Module 2	Microbial Growth	[15 L]

Learning Objectives:

1. To define the concept of microbial growth.
2. To state basic growth kinetics.
3. To measure the growth of microorganisms.
4. To summarize the effect of different environmental factors on microbial growth.

Learning Outcomes:

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

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

1.1	Basic growth terminology: Definition of growth, Prokaryotic cell cycle, gives mathematical formulas.	1 L

1.2	Growth curve and phases of growth: Lag, Log, Stationary and Death phase.	2 L
1.3	Measurement of growth: a. Direct microscopic count, Haemocytometer. b. Measurement of cell mass; growth yield. c. Turbidity measurements - Nephelometric and Spectrophotometric techniques	3 L
1.4	Synchronous culture: Helmstetter Cumming technique: Introduction to continuous culture (Chemostat and Turbidostat)	3 L
1.5	Influence of environmental factors on growth: a. pH b. Temperature c. Aeration d. Salinity e. Radiation	6 L

References:

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

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

Minor Core Course- I

COURSE TITLE: Microbial Diversity and Growth

COURSE CODE: 23US2MBMN1MDG [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	6	6	3	3	3	-	21
II	3	9	3	6	-	-	21
Total marks per objective	9	15	6	9	3	-	42
% Weightage	21	37	14	21	7	-	100

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

Minor Core Course- II

COURSE TITLE: Applied Microbiology

COURSE CODE: 23US2MBMN2AMI [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. Describe the different water-borne diseases and techniques of analysis. 3. Adopt appropriate prophylactic measures.		
Module 1	**Microorganisms in Air and Soil**	**[15 L]**
Learning Objectives: 1. To list and describe different techniques to enumerate microbes in air. 2. To describe the microenvironment of a soil. 3. To recognize different microbial interactions. 4. To 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. Transient nature of air microflora. c. Air sampler sand methods for enumeration of microbesin air.	3 L
1.2	Microorganisms in the terrestrial environment. Soil as an environment and its diversity microorganisms in the soil environment	2 L

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: Concept, significance and associated different microorganisms.	5 L
1.4	Microbial association with vascular plants: 1. Phyllosphere 2. Rhizosphere and Rhizoplane 3. Mycorrhizae and its types 4. Fungal and bacterial endophytes Mechanism of root nodule formation by *Rhizobium*	5 L

References:

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

Module 2	Water Microbiology	[15 L]

Learning Objectives:

1. To describe different water-borne infections.
2. To implement prophylactic measures to avoid infections due to water contamination.

Learning Outcomes:

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

1. Summarize different water-borne infections.
2. Apply suitable Microbiological tests to assess sanitary quality of water.
3. Incorporate prophylactic measures to avoid infections due to water contamination.

2.1	General Account of water-borne infections: Surveillance of microbial infections: Recognition of an infectious disease in a population.	3 L
2.1	Water borne infections: Symptoms and preventive	2 L

	measures for Cholera, Amoebiasis and Giardiasis.	

2. 2	Determining sanitary quality of water: Bacteriological evidence of fecal pollution, indicators of fecal pollution. Biological indicators of fecal pollution. Microbiological analysis of water: SPC, Tests for coliform, MPN, IMViC reactions, membrane filter technique. Water purification in municipal water supply: Source, mode of transmission, symptoms.	7 L
2.4	Prevention and control: General preventive measures, importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by water.	3 L

References:

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

Question Paper Template

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

Minor Core Course- II

COURSE TITLE: Applied Microbiology

COURSE CODE: 23US2MBMN2AMI [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	6	3	6	3	3	-	21
II	6	12	3	-	-	-	21
Total marks per objective	12	15	9	3	3	-	42
% Weightage	29	36	21	7	7	-	100

F. Y. B. Sc. (MICROBIOLOGY)

SEMESTER II - Practical

COURSE CODE: 23US2MBMNP Credit- 02

Course Learning Outcomes
After the successful completion of the practical, the learner will be able to: 1. Implement different techniques to enumerate microbial growth. 2. Monitor microbial growth under controlled conditions. 3. Cultivate different types of microorganisms.
Learning Objectives: 1. To evaluate direct and indirect methods of measurement of growth. 2. To determine the effect of different parameters on growth. 3. To cultivate yeast and fungi. 4. To enumerate and explore air microflora. 5. To establish a miniature pond ecosystem and study the microbial transformations.
Learning Outcomes After the successful completion of the practical, the learner will be able to: 1. Employ effectively different methods to measure microbial growth directly and indirectly. 2. Interpret the effect of different parameters on microbial growth. 3. Select appropriate media for cultivation of yeast and fungi. 4. Quantitatively and qualitatively study air flora of different locations and correlate the results. 5. Establish ecosystems and study the correlation of physical and chemical factors on the growth of microorganisms and their activity.

List of Experiments

Experiment Sr. No.	Title	Number of hours 60
	Major Core Course I	
1	Study of motility (Hanging drop preparation)	02
2	Determination of optimum growth conditions: a. Temperature b. pH c. Salinity d. Aeration	06

3	Measurement of microbial growth: a. Preparation of opacity tubes and determination of cell count. b. Enumeration of cells using haemocytometer. c. Growth curve of *E.coli* and determination of generation time (group experiment).	10
4	Enrichment and isolation of coliphage from sewage. (Demonstration)	02
5	Cultivation of yeasts and molds:	04
	a. Cultivation on Sabourauds agar.	03
	b. Fungal wet mounts and study of morphological characteristics.	03
	c. Slide culture technique.	03
6	Cultivation and Permanent slides of:	
	a. Blue-green algae.	02
	b. Protozoa.	02
	Major Core Course II	
7	Study of air microflora and determination of sedimentation rate.	04
8	Winogradsky column.	06
9	Bacteriological analysis of water: MPN, presumptive, confirmed and completed.	10
10	IMViC test.	03

References:

1. Laboratory Manual in Microbiology by P.Gunasekaran, New Age International Publishers.
2. Laboratory manual in General Microbiology by N.Kannan, Palani Paramount publications.

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.

1. The lectures (of 1 hour duration) delivered to one 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: Mid Semester Examination (MSE) and End Semester Examination (ESE).
- The Mid Semester Examination shall be conducted by the College at the mid of each semester (20 M) – Duration: 30 Min.
- The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1 hour.

End Semester Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	3 M x 7 Q = 21 M	3 M x 5 Q = 15 M
2	II	3 M x 7 Q = 21 M	3 M x 5 Q = 15 M

Each question will have seven sub questions a, b, c, d, e, f, g and out of which any five should be answered.

Evaluation pattern: Practical

- Continuous Assessment for 50 Marks throughout entire semester.
- 50 Marks Evaluation as per the following rubrics

Major Core Course	CIE/ Journal/ Spots/ Quiz	Total
MJ I	25 M	50 M
MJ II	25 M	

10. Programme and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24).
2. Third letter 'U' designates undergraduate.
3. Fourth letter 'S' designates Science discipline and the digit following it is for semester number (S1 – Ist Semester).
4. Letter 'MB' is for Microbiology discipline (MB-Microbiology). This forms the programme code 23USMB. For the further course codes programme code is amended as follows.
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Ability enhancement course code, (AE) alphabets followed by a digit (1/2) followed by 'EVS'-Environmental science are used.
8. For Value Education Course code, (VA) alphabets followed by a digit (1/2) followed by 'EVS'-Environmental science are used.
9. For Indian Knowledge System course code, (IK) alphabets followed by a digit (1/2) followed by 'ICH'- Indian Cultural Heritage is used.
10. For Co-curricular course code, (CC) alphabets followed by a digit (1/2).
11. For Open Elective course code, (OE) alphabets followed by a digit (1/2).
12. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course).