



Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Microbiology

(Faculty of Science & Technology)

F. Y. B. Sc. (Microbiology)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Title of the Course: B. Sc. (Microbiology)

Preamble:

Microbiology is a broad discipline of biology which encompasses five groups of microorganisms i.e. bacteria, protozoa, algae, fungi, viruses. It studies their interaction with their environments as well as how these organisms are harnessed in human endeavour and their impact on society. The study has its extensions in various other conventional and advanced fields of biology by employing microbes as study models. Since inception of microbiology as a branch of science, it has remained an ever-expanding field of active research, broadly categorized as pure and applied science. Microorganisms were discovered over three fifty years ago and it is thought that a huge diversity yet remains to be explored.

Knowledge of different aspects of Microbiology has become crucial and indispensable to the society. Study of microbes has become an integral part of education and human progress. There is a continuous demand for microbiologists as work force – education, industry and research. Career opportunities for the graduate students are available in industry and research equally.

Introduction:

In the post globalization world higher education has to play a significant role in creation of skilled human resources for the well-being of humanity. The barriers among the academic fields seem to have dissolved. However, the disparities in the field of curriculum aspect, evaluation and mobility exist. With the changing scenario at local and global level, the syllabus restructuring should keep pace with developments in the education sector. Choice Based Credit System (CBCS) is being adopted and implemented to address the issues related to traditional system and it also aims to maintain the best of earlier curriculum. The student is at the centre of CBCS. The present curriculum focuses on students' needs, skill development, interdisciplinary approach to learning and enhancing employability.

Microbiology curricula are offered at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible angles. In addition, students are to be trained to apply this knowledge in day-to-day applications and to get a glimpse of research.

Objectives to be achieved:

- To enrich students' knowledge and train them in the pure microbial sciences
- To introduce the concepts of application and research in Microbiology
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

Course Structure:

- For First year: Student has to select 4 different subjects among the subjects offered by the College /Institute.
- For Second year: Student has to select 3 different subjects among 4 subjects chosen in first year.
- For Third year: Student has to select only 1 subject among the 3 subjects opted in second year
- CGPA will be calculated based on core 132 credits only
- Each theory credit is equivalent to 15 clock hours of teaching (12hrs classroom+3hrs of tutorials-active learning method) and each practical credit is equivalent to 30 clock hours of teaching in a semester.
- For the purpose of computation of workload, the following mechanism may be adopted as per UGC guidelines:
 - i) 1 Credit = 1 Theory period of one-hour duration per week
 - ii) 1 Credit = 1 Tutorial period of one-hour duration per week
 - iii) 1 Credit = 1 Practical period of two-hour duration per week
- Each theory Lecture time for FY, SY, TY is of 1 hour = 50 min
- Each practical session time for FY is of 3 hour 15 min = 195 min
- Each practical session time for SY & TY is of 4 hour 20 min = 260 min

Eligibility for Admission:**First Year B.Sc.:**

- a. Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Biology; and two of the science subjects such as Physics, Chemistry, Mathematics, Geography, Geology, etc.

OR
- b. Three Years Diploma in Pharmacy Course of Board of Technical Education conducted by Government of Maharashtra or its equivalent.

OR
- c. Higher Secondary School Certificate (10+2) Examination with English and vocational subject of + 2 level (MCVC) - Medical Lab. Technician (Subject Code = P1/P2/P3)

Admissions will be given as per the selection procedure / policies adopted by the respective college keeping in accordance with conditions laid down by the University of Pune.

Reservation and relaxation will be as per the Government rules.

Medium of Instruction: English**Award of Credits:**

- Each course having 4 credits shall be evaluated out of 100 marks and student should secure at least 40 marks to earn full credits of that course.
- Each course having 2 credits shall be evaluated out of 50 marks and student should secure at least 20 marks to earn full credits of that course.
- GPA shall be calculated based on the marks obtained in the respective subject provided that student should have obtained credits for that course.

Evaluation Pattern:

- Each course carrying 100 marks shall be evaluated with Continuous Assessment (CA) and University Evaluation (UE) mechanism.
- Continuous assessment shall be of 30 marks while University Evaluation shall be of 70 marks. To pass in a course, a student has to secure minimum 40 marks provided that he should secure minimum 28 marks in University Evaluation (UE).
- Each course carrying 50 marks shall be evaluated with Continuous Assessment (CA) and University Evaluation (UE) mechanism.
- Continuous assessment shall be of 15 marks while University Evaluation shall be of 35 marks.
- To pass in a course, a student has to secure minimum 20 marks provided that he/she should secure minimum 14 marks in University Evaluation (UE).
- For Internal examination minimum two tests per paper of which one has to be a written test 10 marks
- Methods of assessment for Internal exams: Seminars, Viva-voce, Projects, Surveys, Field visits, Tutorials, Assignment, Group Discussion, etc (on approval of the head of the centre)

ATKT Rules:

- Minimum number of credits required to take admission to Second Year of B. Sc.: 22
- Minimum number of credits required to take admission to Third Year of B.Sc.: 44

Completion of Degree Course:

- A student who earns 140 credits, shall be considered to have completed the requirements of the B. Sc. degree program and CGPA will be calculated for such student

Titles of Papers and Scheme of Study Evaluation

F. Y. B.Sc. Microbiology

Semester	Paper Code	Paper	Paper title	credits	Lectures/Week			Evaluation		
					Th.	Tut.	Pr.	CA	UE	Total
I	MB 111	I	Introduction to Microbial World	2	2			15	35	50
	MB 112	II	Basic Techniques in Microbiology	2	2			15	35	50
	MB113	III	Practical Course based on theory paper I and II	1.5			3	15	35	50
II	MB121	I	Bacterial Cell and Biochemistry	2	2			15	35	50
	MB122	II	Microbial cultivation and growth	2	2			15	35	50
	MB123	III	Practical Course based on theory paper I and II	1.5			3	15	35	50

S. Y. B. Sc. Microbiology

Semester	Paper Code	Paper	Paper title	credits	Lectures/Week			Evaluation		
					Th	Tut	Pr.	CA	UE	Total
III	MB 211	I	Bacterial Systematics and Physiology	2	2			15	35	50
	MB 212	II	Industrial Microbiology	2	2			15	35	50
	MB213	III	Practical based on MB211 & MB 212	2			4	15	35	50
IV	MB221	I	Bacterial Genetics	2	2			15	35	50
	MB222	II	Air Water & Soil Microbiology	2	2			15	35	50
	MB223	III	Practical based on MB211 & MB 212	2			4	15	35	50

T. Y. B. Sc. Microbiology Proposed Structure

	Paper	Paper Title	Marks	Lecture
Semester V	MB 331 TC	Medical Microbiology I	50	2 Credits /per TC
	MB 332 TC	Genetics and Molecular Biology I	50	
	MB 333 TC	Enzymology	50	
	MB 334 TC	Immunology I	50	
	MB 335 TC	Fermentation technology I	50	
	MB 336 Elective Course TE	Applied Microbiology I (Elective Course)	50	2 Credits /TE
	TE 1	Dairy Microbiology		
	TE 2	Agricultural Microbiology		
	TE 3	Marine Microbiology		
	TE 4	Space Microbiology		
	MB 337 PC	Practical Course I	50	2 Credits /per PC
	MB 338 PC	Practical Course II	50	
	MB 339 PC	Practical Course III	50	
	Semester VI	MB 341 TC	Medical Microbiology II	50
MB 342 TC		Genetics and Molecular Biology II	50	
MB 343 TC		Metabolism	50	
MB 344 TC		Immunology II	50	
MB 345 TC		Fermentation technology II	50	
MB 346 Elective Course TE		Applied Microbiology II (Elective Course)	50	2 Credits /TE
TE 5		Food Microbiology		
TE 6		Geomicrobiology		
TE 7		Nanobiotechnology		
TE 8		Waste Management		
MB 347 PC		Practical Course I	50	2 Credits /per PC
MB 348 PC		Practical Course II	50	

	MB 349 PC	Practical Course III	50	
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- In addition to the compulsory credit of 132, the student has to earn additional 8 credits from following groups by taking/participating/conducting respective activities.

1. Courses in Group I are compulsory.

The student can earn maximum 04 credits from an individual group from Group 2 to Group-9. These extra credits will not be considered for GPA calculation; however, these are mandatory for the completion and award of B. Sc. Degree.

Group 1: Physical Education (at F. Y.B. Sc. Sem. I)-01 credit

Physical Education (at F. Y.B. Sc. Sem. II)-01 credit (Note: Group I is compulsory for all the students as stated above.)

Group 2: Sport representation at College level-01 credit

Sport representation at University/State level-02 credits

Group 3: National Social Service Scheme (participation in Camp): 01 credits

N.C.C. (with participation in annual camp)-01 credit

N. C. C. (with B certificate/C certificate award)-02 credits

N.S.S./N.C.C. Republic day parade participation-04 credits

Group 4: Avishkar participation; Extension activity participation, Cultural activity participation-

01 credit, Avishkar selection at University level-02 credits. Avishkar winner at state level-04 credits

Group 5: Research paper presentation at State/National level-01 credits. Research paper presentation at International level-02 credits

Group 6: Participation in Summer school/programme; Short term course (not less than 1-week duration) -03 credit. **Group 7:** Scientific Survey, Societal survey,-02 credits.

Group 8: Field Visits; Study Tours; Industrial Visits; Participation in curricular/ cocurricular competitions-01 Credit.

Group 9: Online certificate Courses /MOOC Courses/ Career Advancement Course up to 04 credits (Minimum10 Hrs. / credit)

Equivalence of Previous Syllabus:F. Y. B. Sc. Microbiology

Sem	Old Course (2013 Pattern)	New Course (2019 Pattern)
I	Introduction to Microbiology	Introduction to Microbial World
	Basic Techniques in Microbiology	Basic Techniques in Microbiology
	Practical Course	Practical Course based on theory paper I and II
II	Introduction to Microbiology	Bacterial Cell and Biochemistry
	Basic Techniques in Microbiology	Microbial cultivation and growth
	Practical Course	Practical Course based on theory paper I and II

External Students

There shall be no external students.

University Terms

Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 80 percent attendance at theory and practical course and satisfactory performance during the term.

Current curriculum orientation

To accommodate more advanced topics in the syllabi, it is necessary to understand the basic science knowledge level of the students that have chosen the Microbiology discipline. Curricula of courses of state and central boards of higher secondary level were reviewed to avoid reiterations of previous syllabi.

At **first year of under-graduation**, students will be provided the basic information that includes – characteristics of microbial world. The microorganisms will be studied for morphological, structural characterization, isolations techniques from natural and extreme environments and their prominent features. The methodology to develop keen observation i.e. different microscopy techniques, staining techniques and nutritional requirements will be taught in detail; including these aspects at laboratory level as well. Introduction to biochemical characterization of components of micro-organism e.g. proteins, lipids, nucleic acids and carbohydrates and instrumental techniques to estimate these components qualitatively and quantitatively from micro-organisms or other natural sources will be the focus for second theory paper. Relevant experimentation on these topics will be included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and logbooks.

At **second year under-graduation** includes paper on principles of taxonomy and classification of major groups of microorganisms. The said paper will also include the physiological studies on these groups of microorganisms. Second paper will deal with Air and Water Microbiology; role of micro-organisms in environment in regard to pollution and biodegradation; water and sewage treatment. Practical for the second-year students will be designed to be flexible incorporating project themes on environment, agriculture and pollution aspects to acquire laboratory skills. Practical at this level will also include application of biostatistics principles, computers for data analysis, interpretation, introduction to scientific writing and report preparation. These aspects can be better while carrying out the mini projects.

At **third year under-graduation**, The six theory papers will deal with broad areas of microbiology. Five such areas are – Medical microbiology, Microbial physiology, Microbial (prokaryotic and eukaryotic) genetics, Immunology and Fermentation technology. The sixth course will be Applied Microbiology that will include – Dairy Microbiology, Food Microbiology, Fermentation Technology, Agriculture Biotechnology, Fungal Biotechnology, etc. The practicals at third year will be planned more intensively, with exposure to applied fields and hands-on training.

Qualification of Teachers:

With minimum undergraduate and postgraduate degree in Microbiology (B. Sc. and M. Sc. Microbiology) and qualified as per UGC regulations.

Semester I

Paper I: Introduction to Microbial World

Sr. No.	Topic	No. of Hours
Credit One	Amazing world of Microbiology	(15)
	Development of microbiology as a discipline -Discovery of microscope and Microorganisms (Anton von Leeuwenhoek and Robert Hooke), Abiogenesis v/s biogenesis (Aristotle's notion about spontaneous generation, Francesco Redi's experiment, Louis Pasteur's & Tyndall's experiments)	4
	Golden Era of Microbiology Contributions of - Louis Pasteur (Fermentation, Rabies, Pasteurization and Cholera vaccine-fowl cholera experiment) Robert Koch (Koch's Postulates, Germ theory of disease, Tuberculosis and Cholera-isolation and staining techniques of causative agent) Ferdinand Cohn (Endospore discovery), Discovery of viruses (TMV and Bacteriophages), River's Postulates	3
	Contribution of Joseph Lister (antiseptic surgery), Paul Ehrlich (Chemotherapy), Elie Metchnikoff (Phagocytosis), Edward Jenner (Vaccination) and Alexander Fleming (Penicillin) in establishment of fields of medical microbiology and immunology, Discovery of Streptomycin by Waksman	3
	Contribution of Martinus W. Beijerinck (Enrichment culture technique, Rhizobium), Sergei N. Winogradsky (Nitrogen fixation and Chemo-lithotrophy) in the development of the field of soil microbiology	2
	Modern Era of Microbiology Carl Woese classification based on 16S rRNA Signification and Application of Human Microbiome, Nano-biotechnology and Space Microbiology	1
	Nobel laureates in Life Sciences of 21st Century <i>(Project Based Learning: Assignments should be given to student)</i>	2
Credit Two	Types of Microorganism and their differentiating characters	(15)
	-- Prokaryotes, Eukaryotes, three domain and five domain system of classification	1
	--Bacteria (Eubacteria and Archaeobacteria)	1
	--Protozoa	1
	--Fungi	1
	--Algae	1

--Viruses, Viroids and Prions	1
--Actinomycetes	1
Beneficial and Harmful effects of microorganisms:	
Medical Microbiology (Enlist diseases caused by various microorganisms, vaccines and antibiotics)	1
Environmental Microbiology (Eutrophication, red tide, Sewage treatment, bioremediation)	2
Food and Dairy Microbiology (Food spoilage, food borne diseases, Probiotics and fermented food)	1
Agriculture Microbiology (Plant diseases and Biofertilizers and Bio-control agents)	1
Industrial Microbiology (Production of antibiotics, enzymes, solvents and contaminants-bacteria and phages)	2
Immunology (Normal flora, Three lines of defence)	1

Semester II

Paper I: Bacterial Cell and Biochemistry

Sr. No.	Topic	No. of Hours
Credit One	Bacterial Cytology - Microbial cell size, shape and arrangements	(15) 1
	Structure, chemical composition and functions of the following components in bacterial cell:	
	--Cell wall (Gram positive, Gram negative) Concept of Mycoplasma, Spheroplast, protoplast, L-form	3
	--Cell membrane	1
	--Endospore (spore formation and stages of sporulation)	1
	--Capsule	1
	--Flagella	1
	--Fimbriae and Pili	1
	--Ribosomes	1
	--Chromosomal & extra-chromosomal material	1
--Cell inclusions (Gas vesicles, carboxysomes, PHB granules, metachromatic granules, glycogen bodies, starch granules, magnetosomes, sulfur granules, chlorosomes)	4	
Credit Two	Chemical Basis of Microbiology	(15)
	Atom, Biomolecules, types of bonds (covalent, co-ordinate bond, non-covalent) and linkages (ester, phospho-diester, peptide, glycosidic)	2

	<p>Chemistry of Biomolecules: Structure, organization and functions</p> <p>Carbohydrates: Definition, classification</p> <ul style="list-style-type: none"> i. Monosaccharides: Classification based on aldehyde and ketone groups; structure of Ribose, Deoxyribose, Glucose, Galactose and Fructose. 1 ii. Disaccharides: Glycosidic bond, structure of lactose and sucrose. 1 iii. Polysaccharides: Structure and types 2 Examples-Starch, glycogen, Peptidoglycan, chitin <p>Lipids: Definition, classification 2</p> <ul style="list-style-type: none"> i. Simple lipids – Triglycerides, Fats and oils, waxes. ii. Compound lipids – Phospholipid, Glycolipids iii. Derived lipids – Steroids, Cholesterol <p>Proteins: Definition, classification</p> <ul style="list-style-type: none"> i) General structure of amino acids, peptide bond. 1 ii) Types of amino acids based on R group 1 iii) Structural levels of proteins: primary, secondary, tertiary and quaternary 1 iv) Study of Hemoglobin, flagellin and cytoskeletal proteins 1 <p>Nucleic acids: Definition, classification 1</p> <ul style="list-style-type: none"> i) DNA – structure and composition ii) RNA – Types (m-RNA, t-RNA, r-RNA), structure and functions. <p>Classification of Bacteria - Introduction to Bergey's Manual of Determinative and Systemic Bacteriology 2</p> <p>Classification of Viruses: ICTV nomenclature</p>	
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Semester I
Paper II: Basic Techniques in Microbiology

Serial No.	Topic	No. of Hours
Credit One	I. Units of measurement – Introduction to Modern SI units	(08)
	Microscopy:	
	1. Bright field microscopy:	3
	<ul style="list-style-type: none"> • Electromagnetic spectrum of light • Structure, working of and ray diagram of a compound light microscope; concepts of magnification, numerical aperture and resolving power. • Types, ray diagram and functions of – condensers (Abbe and cardioid) eyepieces and objectives • Concept of aberrations in lenses - spherical, chromatic, comma and astigmatism 	
	2. Principle, working and ray diagram of	
	<ul style="list-style-type: none"> i. Phase contrast microscope ii. Fluorescence Microscopy iii. Electron Microscopy – TEM, SEM 	1 1 2
	II. Staining Techniques:	(07)
	<ul style="list-style-type: none"> • Definition of Stain; Types of stains (Basic and Acidic), Properties and role of Fixatives, Mordants, Decolourisers and Accentuators • Monochrome staining and Negative (Relief) staining • Differential staining - Gram staining and Acid-fast staining • Special staining- Capsule, Cell wall, Spore, Flagella, Lipid granules, metachromatic granules 	1 1 2 3
Credit II	Sterilization and Disinfection	(15)
	1. Sterilization	
	<ul style="list-style-type: none"> • Physical Agents - Heat, Radiation, Filtration • Checking of efficiency of sterilization (Dry and Moist) – Biological and Chemical Indicators 	3 3
	2. Disinfection:	
	<ul style="list-style-type: none"> • Chemical agents and their mode of action - Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds, • Heavy metals, Alcohol, Dyes, Detergents and Ethylene oxide. • Characteristics of an ideal disinfectant • Checking of efficiency of disinfectant - Phenol Coefficient (Rideal–Walker method) 	4 3 1 1

Semester II

Paper II: Microbial cultivation and growth

Serial No.	Topic	No. of Hours
Credit One	Cultivation of Microorganisms:	(15)
	1.Nutritional requirements and nutritional classification	2
	2.Design and preparation of media: Common ingredients of media and types of media	2
	3.Methods for cultivating photosynthetic, extremophilic and chemo-lithotrophic bacteria, anaerobic bacteria, algae, fungi, actinomycetes and viruses	4
	4.Concept of Enrichment, Pure Culture, Isolation of culture by streak plate, pour plate, spread plate	2
	5. Maintenance of bacterial and fungal cultures using different techniques	
	6. Culture collection centres and their role	3
	7. Requirements and guidelines of National Biodiversity Authority for culture collection centres	1 1
Credit Two	Bacterial growth:	(15)
	1. Kinetics of bacterial growth (Exponential growth model)	2
	2. Growth curve and Generation time	2
	3. Diauxic growth	1
	4. Measurement of bacterial growth- Methods of enumeration:	
	• Microscopic methods (Direct microscopic count, counting cells using improved Neubauer, Petroff-Hausser's chamber)	3
	• Plate counts (Total viable count)	1
	• Turbidometric methods (including Nephelometry)	1
• Estimation of biomass (Dry mass, Packed cell volume)	1	
• Chemical methods (Cell carbon and nitrogen estimation)	1	
5. Factors affecting bacterial growth {pH, Temperature, Solute Concentration (Salt and Sugar)} and Heavy metals	3	

**F. Y. B. Sc. Microbiology Practical Course (Implemented from 2019)
based on theory paper I and II**

Semester I		
Expt. No.	Topics	No. of Practicals
1	i. Safety measures and Good Laboratory Practices in microbiology laboratory ii. Introduction, operation, precautions and use of common microbiology laboratory instruments: Incubator, Hot air oven, Autoclave, Colorimeter, Laminar air flow hood, Clinical centrifuge.	2
2	i. Construction (mechanical and optical), working and care of bright field microscope. ii. Permanent slide observation: Algae, Fungi and Protozoa iii. Wet mount slide preparation and its observation for: Bacteria, Algae, Fungi and Protozoa.	3
3	i. Introduction and use of common laboratory glass wares: Test tubes, culture tubes, suspension tubes, screw capped tubes, Petri plates, pipettes (Mohr and serological) micropipettes, Pasteur pipettes, Erlenmeyer flask, volumetric flask, glass spreader, Durham's tube, Cragie's tube and inoculating needles (wire loop, stab needles). ii. Learning basic techniques in Microbiology: Wrapping of glassware, cotton plugging, cleaning and washing of glassware, biological waste disposal.	2
4	Basic staining techniques: i. Monochrome staining ii. Negative staining iii. Gram staining of bacteria	3
5	Observation of motility in bacteria using: Hanging drop method and swarming growth method.	2
6.	Checking of efficacy of chemical disinfectant: Phenol Coefficient by Rideal-Walker method.	2
	TOTAL	14

Semester II		
Expt. No.	Topics	No. of Practicals
1	i. Preparation of simple laboratory nutrient media (Nutrient agar/broth, MacConkey's agar). ii. Checking sterilization efficiency of autoclave using a biological indicator (<i>B. stearothermophilus</i>) iii. Preparation of Winogradsky's column and observation of different types of microorganisms using bright field microscope	3
2	Special staining techniques: i. Endospore staining ii. Capsule staining	2
3	Isolation of bacteria by streak plate technique (Colony and cultural characteristics)	1
4	Enumeration of bacteria from fermented food / soil / water by: i. Spread plate method ii. Pour plate method	2
5	Study of normal flora of skin: i. Cultivating and observing different morphoforms of bacteria from skin. ii. Study of effect of washing on skin with soap and disinfectant on it's microflora	2
6	i. To study the effect of different parameters on growth of <i>E. coli</i> : pH, temperature, sodium chloride concentration ii. Study of oligodynamic action of heavy metal	3
7	Preservation of cultures on slants, soil and on grain surfaces; revival of these cultures and lyophilized cultures.	1
	TOTAL	14
