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)

2019 Pattern

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 (12 hrs classroom+3 hrs 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:
- Each theory Lecture time for FY, SY, TY is of 1 lecture = 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 minimum14 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

1. In addition to the compulsory credits of 132, the student has to earn additional 8 credits from following groups by taking/participating/conducting respective activities.
2. Courses in Group-I are compulsory.
3. 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)-01credit (Note: Group I is compulsory for all the students as stated above.)

Group 2: Sport representation at Collegelevel-01 credit
Sport representation at University/Statelevel-02 credits

Group 3: National Social Service Scheme (participation in Camp): 01 credits
N.C.C. (with participation in annual camp)-01credit
N. C. C. (with B certificate/C certificate award)-02 credits
N.S.S./N.C.C. Republicdayparadeparticipation-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-04credits

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/ co curricular competitions -01 Credit.

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

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 papers MB 111 and MB112	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 papers MB121 and MB122	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 231	I	Medical Microbiology and Immunology	2	2			15	35	50
	MB 232	II	Bacterial Physiology and Fermentation	2	2			15	35	50
	MB 233	III	Practical Course based on theory papers MB 231 and MB 232	2			4	15	35	50
IV	MB 241	I	Bacterial Genetics	2	2			15	35	50
	MB 242	II	Air, Water and Soil Microbiology	2	2			15	35	50
	MB 243	III	Practical Course based on theory papers MB241 and MB 242	2			4	15	35	50

T. Y. B. Sc. Microbiology Proposed Structure
Semester V

Semester	Theory/ Practical / Skill Enhancement	Paper	Paper Title	Marks	Lecture
Sem V	Discipline Specific Elective Course Theory (DSECT)	MB 351 TC	Medical Microbiology- I	50	2 Credits /per TC
		MB 352 TC	Immunology- I	50	
		MB 353 TC	Enzymology	50	
		MB 354 TC	Genetics	50	
		MB 355 TC	Fermentation technology- I	50	
		MB 356 TC	Agricultural Microbiology	50	
	Discipline Specific Elective Course Practical (DSECP)	MB 357 PC	Practical Course I	50	2 Credits /per PC
		MB 358 PC	Practical Course II	50	
		MB 359 PC	Practical Course III	50	
	Skill Enhancement course (SE)	MB 3510 SE	Marine microbiology	50	2 Credits
		MB 3511SE	Dairy Microbiology	50	2 Credits
Sem VI	Discipline Specific Elective Course Theory (DSECT)	MB 361 TC	Medical Microbiology- II	50	2 Credits /per TC
		MB 362 TC	Immunology- II	50	
		MB 363 TC	Metabolism	50	
		MB 364 TC	Molecular Biology II	50	
		MB 365 TC	Fermentation technology II	50	
		MB 366 TC	Food Microbiology	50	
	DisciplineSpecific Elective Course Practical (DSECP)	MB 367 PC	Practical Course I	50	2 Credits /per PC
		MB 368 PC	Practical Course II	50	
		MB 369 PC	Practical Course III	50	
	Skill Enhancement courses (SE)	MB 3610 SE	Waste management	50	2 Credits
		MB 3611 SE	Nanobiotechnology	50	2 Credits

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

Semester	Old Course (2013 Pattern)		New Course (2019 Pattern)	
	Course Number	Course title	Course Number	Course title
I	Theory Paper I	Introduction to Microbiology	MB 111	Introduction to Microbial World
	Theory Paper II	Basic Techniques in Microbiology	MB 112	Basic Techniques in Microbiology
	—	Practical Course (Term I & II)	MB 113	Practical Course based on theory paper I (MB 111) and Paper II (MB 112)
II	Theory Paper I	Introduction to Microbiology	MB 121	Bacterial Cell and Biochemistry
	Theory Paper II	Basic Techniques in Microbiology	MB 122	Microbial cultivation and growth
	—	Practical Course (Term I & II)	MB 123	Practical Course based on theory paper I (MB 121) and Paper II (MB 122)

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 micro-organisms. 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 planed 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
MB 111: Introduction to Microbial World

Credit	Topic	No. of Lectures (36)
Credit I	**1. Amazing world of Microbiology**	
	a. 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**
	b. Golden Era of Microbiology	
	i. 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)	**4**
	ii. Discovery of viruses (TMV and Bacteriophages), River's Postulates,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	**4**
	iii. 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**
	c. Modern Era of Microbiology Carl Woese classification based on 16S r RNA Signification and Application of Human Microbiome, Nano-biotechnology and Space Microbiology	**2**
	d. Nobel laureates in Life Sciences of 21st Century (*Project Based Learning: Assignments should be given to student*)	**2**

Credit II	**2. Types of Microorganism and their differentiating characters**	
	a. Prokaryotes, Eukaryotes, three domain and five domain system of classification	**2**
	b. Bacteria (Eubacteria and Archaebacteria)	**1**
	c. Protozoa	**1**
	d. Fungi	**1**
	e. Algae	**1**
	f. Viruses, Viroids and Prions	**2**
	g. Actinomycetes	**1**
	3. Beneficial and Harmful effects of microorganisms:	
	a. Medical Microbiology (Enlist diseases caused by various microorganisms, vaccines and antibiotics)	**1**
	b. Environmental Microbiology (Eutrophication, red tide, Sewage treatment, bioremediation)	**2**
	c. Food and Dairy Microbiology (Food spoilage, food borne diseases, Probiotics and fermented food)	**1**
	d. Agriculture Microbiology (Plant diseases and Biofertilizers and Bio-control agents)	**1**
	e. Industrial Microbiology (Production of antibiotics, enzymes, solvents and contaminants-bacteria and phages)	**2**
	f. Immunology (Normal flora, Three lines of defence)	**2**

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Semester I

MB 112: Basic Techniques in Microbiology

Credit	Topic	No. of Lectures (36)
I	**1. Units of measurement – Introduction to Modern SI units**	**1**
	2. Microscopy	
	a. Bright field microscopy:	**3**
	• 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	
	b. Principle, working and ray diagram of	
	• Phase contrast microscope	**2**
	• Fluorescence Microscopy	**1**
	• Electron Microscopy – TEM, SEM	**3**

	3. Staining Techniques: **a.** Definition of Stain; Types of stains (Basic and Acidic), Properties and role of Fixatives, Mordants, Decolourisers and Accentuators **b.** Monochrome staining and Negative (Relief) staining **c.** Differential staining - Gram staining and Acid-fast staining **d.** Special staining- Capsule, Cell wall, Spore, Flagella, Lipid granules, metachromatic granules	**2** **1** **2** **3**
II	**4. Sterilization and Disinfection** **a. Sterilization** • Physical Agents - Heat, Radiation, Filtration • Checking of efficiency of sterilization (Dry and Moist) – Biological and Chemical Indicators **b. Disinfection:** • 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)	 **3** **4** **4** **4** **1** **2**

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F. Y. B. Sc. Microbiology Practicals Syllabus

Semester I Practical Course MB 113 (Implemented from 2019) Based on theory paper I (MB 111) and Paper II (MB 112)		
Expt. No.	**Topics**	**No. of Practicals**
1	a. Safety measures and Good Laboratory Practices in microbiology laboratory. b. Introduction, operation, precautions and use of common microbiology laboratory instruments: Incubator, Hot air oven, Autoclave, Colorimeter, Laminar air flow hood, Clinical centrifuge.	**2**
2	a. Construction (mechanical and optical), working and care of bright field microscope. b. Permanent slide observation: Algae, Fungi and Protozoa c. Wet mount slide preparation and its observation for: Bacteria, Algae, Fungi and Protozoa.	**3**
3	a. 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). b. Learning basic techniques in Microbiology: Wrapping of glassware, cotton plugging, cleaning and washing of glassware, biological waste disposal.	**2**
4	Basic staining techniques: a. Monochrome staining b. Negative staining c. 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**

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Semester II
MB 121: Bacterial Cell and Biochemistry

Credits	Topic	No. of Lectures (36)
I	**1. Bacterial Cytology**	**1**
	Microbial cell size, shape and arrangements	
	2. Structure, chemical composition and functions of the following components in bacterial cell:	
	a. Cell wall (Gram positive, Gram negative)	**2**
	b. Concept of Mycoplasma, Spheroplast, protoplast, L-form	**1**
	c. Cell membrane	**2**
	d. Endospore (spore formation and stages of sporulation)	**1**
	e. Capsule	**1**
	f. Flagella	**2**
	g. Fimbriae and Pili	**1**
	h. Ribosomes	**1**
	i. Chromosomal & extra-chromosomal material	**2**
	j. Cell inclusions (Gas vesicles, carboxysomes, PHB granules, metachromatic granules, glycogen bodies, starch granules, magnetosomes, sulfur granules, chlorosomes)	**4**
II	**3. Chemical Basis of Microbiology**	
	a. Atom, Biomolecules, types of bonds (covalent, co-ordinate bond, non-covalent) and linkages (ester, phospho-diester, peptide, glycosidic)	**2**
	b. Chemistry of Biomolecules: Structure, organization and functions	**1**
	4. Carbohydrates: Definition, classification	
	a. Monosaccharides: Classification based on aldehyde and ketone groups; structure of Ribose, Deoxyribose, Glucose, Galactose and Fructose.	**1**
	b. Disaccharides: Glyosidic bond, structure of lactose and sucrose.	**1**
	c. Polysaccharides: Structure and types Examples-Starch, glycogen, Peptidoglycan, chitin	**2**

	5. Lipids: Definition, classification **a.** Simple lipids – Triglycerides, Fats and oils, waxes. **b.** Compound lipids – Phospholipid, Glycolipids **c.** Derived lipids – Steroids, Cholesterol	**2**
	6. Proteins: Definition, classification **a.** General structure of amino acids, peptide bond. **b.** Types of amino acids based on R group **c.** Structural levels of proteins: primary, secondary, tertiary and quaternary **d.** Study of Hemoglobin, flagellin and cytoskeletal proteins	 **1** **1** **1** **1**
	7. Nucleic acids: Definition, classification **a.** DNA – structure and composition **b.** RNA – Types (m-RNA, t-RNA, r-RNA), structure and functions.	**2**
	8. Classification of Bacteria: Introduction to Bergey's Manual of Determinative and Systemic Bacteriology	**2**
	9. Classification of Viruses: ICTV nomenclature	**1**

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Semester II
MB 122: Microbial cultivation and growth

Credit	Topic	No. of Lectures (36)
I	**1. Cultivation of Microorganisms:**	
	a. Nutritional requirements and nutritional classification.	**3**
	b. Design and preparation of media: Common ingredients of media and types of media.	**3**
	c. Methods for cultivating photosynthetic, extremophilic and chemo-lithotrophic bacteria, anaerobic bacteria, algae, fungi, actinomycetes and viruses.	**4**
	d. Concept of Enrichment, Pure Culture, Isolation of culture by streak plate, pour plate, spread plate.	**3**
	e. Maintenance of bacterial and fungal cultures using different techniques.	**3**
	f. Culture collection centres and their role.	**1**
	g. Requirements and guidelines of National Biodiversity Authority for culture collection centres.	**1**
II	**2. Bacterial growth:**	
	a. Kinetics of bacterial growth (Exponential growth model)	**3**
	b. Growth curve and Generation time	**2**
	c. Diauxic growth	**1**
	d. Measurement of bacterial growth- Methods of enumeration:	**4**
	e. Microscopic methods (Direct microscopic count, counting cells using improved Neubauer, Petroff-Hausser's chamber)	
	f. Plate counts (Total viable count)	**1**

	g. Turbidometric methods (including Nephelometry)	**1**
	h. Estimation of biomass (Dry mass, Packed cell volume)	**1**
	i. Chemical methods (Cell carbon and nitrogen estimation)	**1**
	j. Factors affecting bacterial growth [pH, Temperature, Solute Concentration (Salt and Sugar)] and Heavy metals.	**4**

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Semester II Practical Course MB 123 based on theory paper I (MB 121) and Paper II (MB 122)		
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 (*B. stearothermophilus*) **iii.** Preparation of Winogradsky's column and observation of different types of microorganisms using bright field microscope.	1 1 1
2	**Special staining techniques:** **i.** Endospore staining **ii.** Capsule staining	2
3	**Isolation of bacteria:** 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 morpho-forms of bacteria from skin. **ii.** Study of effect of washing on skin with soap and disinfectant on it's microflora.	2
6	**To study the effect of different parameters on growth of *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**

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