Maharashtra Education Society's

Abasaheb Garware College

(Autonomous)

(Affiliated to Savitribai Phule Pune University)

Three Year B.Sc. Degree Program in Microbiology
(Faculty of Science and Technology)

Syllabi under Autonomy
F.Y.B.Sc. (Microbiology)

Choice Based Credit System Syllabus
To be implemented from Academic Year 2022-2023

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.

Program outcome:

- 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

Eligibility for Admission:

First Year B.Sc.:

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

Reservation and relaxation will be as per the Government rules.

Structure of the Course: (Microbiology)

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
1	I	Compulsory	USMR- 111	Introduction to Microbial World	Theory	2	36
		Compulsory	USMR- 112	Basic Techniques in Microbiology	Theory	2	36
		Compulsory	USMRP- 113	Practical Course based on theory paper I (USMR-111) and Paper II (USMR-112)	Practical	1.5	14
	II	Compulsory	USMR- 121	Bacterial Cell and Biochemistry	Theory	2	36
		Compulsory	USMR- 122	Microbial cultivation and growth	Theory	2	36
		Compulsory	USMRP- 123	Practical Course based on theory paper I (USMR-121) and Paper II (USMR-122)	Practical	1.5	14
2	III	Compulsory	USMR-231	Medical Microbiology and Immunology	Theory	2	36
		Compulsory	USMR-232	Bacterial physiology and Fermentation Technology	Theory	2	36
		Compulsory	USMRP-233	Practical based on USMR-231and USMR232	Practical	2	12
		Compulsory	USLG-231	Language	Theory	2	36
		Compulsory	AACC-231	Environmental Science	Theory	2	36
	IV	Compulsory	USMR-241	Bacterial Genetics	Theory	2	36
		Compulsory	USMR-242	Air, Water and Soil Microbiology	Theory	2	36
		Compulsory	USMRP-243	Practical basedon USMR-241and USMR-242	Practical	2	12
		Compulsory	USLG-241	Language	Theory	2	36
		Compulsory	AACC-241	Environmental Science	Theory	2	36
3	V	DSEC-Compulsory	USMR- 351	Medical Microbiology- I	Theory	2	36
		DSEC-Compulsory	USMR- 352	Immunology- I	Theory	2	36
		DSEC-Compulsory	USMR- 353	Enzymology	Theory	2	36
		DSEC-Compulsory	USMR- 354	Genetics	Theory	2	36
		DSEC-Compulsory	USMR- 355	Fermentation technology- I	Theory	2	36
		DSEC-Compulsory	USMR- 356	Agricultural Microbiology	Theory	2	36
		DSEC-Compulsory	USMRP- 357	Practical Course I	Practical	2	12

		DSEC-Compulsory	USMRP- 358	Practical Course II	Practical	2	12
		DSEC-Compulsory	USMRP- 359	Practical Course III	Practical	2	12
		SEC-Compulsory	USMRSEC-3510	Marine microbiology	Theory/ practical	2	36
		SEC-Compulsory	USMRSEC-3511	Dairy Microbiology	Theory/ practical	2	36
	VI	DSEC-Compulsory	USMR- 361	Medical Microbiology- II	Theory	2	36
		DSEC-Compulsory	USMR- 362	Immunology- II	Theory	2	36
		DSEC-Compulsory	USMR- 363	Metabolism	Theory	2	36
		DSEC-Compulsory	USMR-364	Molecular Biology	Theory	2	36
		DSEC-Compulsory	USMR- 365	Fermentation technology II	Theory	2	36
		DSEC-Compulsory	USMR- 366	Food Microbiology	Theory	2	36
		DSEC-Compulsory	USMRP- 367	Practical Course I	Practical	2	12
		DSEC-Compulsory	USMRP- 368	Practical Course II	Practical	2	12
		DSEC-Compulsory	USMRP- 369	Practical Course III	Practical	2	12
		SEC-Compulsory	USMRSEC-3610	Waste management	Theory/ practical	2	36
		SEC-Compulsory	USMRSEC-3611	Nanobiotechnology	Theory/ practical	2	36

DSEC: Discipline Specific Elective Course, SEC: Skill Enhanced Course

SEMESTER-I

Course code and title: USMR-111 Introduction to Microbial World

Lectures: (Credits- 02)

Course Outcomes:

1. Students will understand the contributions of different scientists in the fields of Microbial science.
2. Students will have knowledge about different types of microbes.
3. Students will have knowledge about the established and emerging fields of science with respect to Microbiology.

Credit	Topic	No. of Lectures (36)
Credit I	**1. History of Microbiology in developing as a Modern fundamental Science.** ❖ **Discovery Era:** Discovery of Microorganisms (Contributions of Anton von Leeuwenhoek and Robert Hooke). ❖ **Transition Era: Conflict of Abiogenesis v/s biogenesis theory** ❖ **Golden Era of Microbiology:** ➢ Birth of Bacteriology, Medical Microbiology and Virology due to Contributions of following scientists: ○ Louis Pasteur (Fermentation, Pasteurization) ○ Contribution of Robert Koch (Germ theory of disease, Tuberculosis and Cholera, concept of Pure culture) ○ Ferdinand Cohn (Endospore discovery). ○ Discovery of viruses, River's Postulates. ○ Breakthroughs in medical field: Contribution of Joseph Lister (antiseptic surgery), Paul Ehrlich (Chemotherapy), Alexander Fleming (Penicillin), Discovery of Streptomycin by Walksman. ➢ Establishment of Immunology: Vaccination, First Laboratory Vaccine, Story of Rabies vaccine, contribution of Elie Metchnikoff (Phagocytosis). ➢ Development of Soil Microbiology: Contribution of Martinus W. Beijerinck, Sergei N. Winogradsky. ❖ **Modern Era of Microbiology (**Contribution of Carl Woese) **2. Public Health and Microbiology:** COVID -19 Pandemic (*Project Based Learning: Assignments should be given to student*)	**2** **3** **4** **3** **3** **1** **1** **1**

Credit II	2. **Systems of Classification: Comparative account of Prokaryotes and Eukaryotes, Three domain classification and Five kingdom classification.**	2
	3. **Types of Microorganism and their differentiating characters (with emphasis on distribution and occurrence, morphology, classification, mode of reproduction and medical /economic/ environmental importance)**	
	a. Bacteria (Eubacteria, Archaebacteria, Actinomycetes)	
	b. Protozoa	6
	c. Fungi	
	d. Algae	
	e. Viruses (**Classification of Viruses: ICTV** nomenclature)	
	f. Viroids and Prions	
	3. Scope of studying microorganisms:	
	a. Bacterial Taxonomy - Introduction to Bergey's Manual of Systematics of Archae & Bacteria (BMSAB) and Bergey's International Society for Microbial Taxonomy (BISMIS).	2
	b. Medical Microbiology	1
	c. Environmental Microbiology	1
	d. Food and Dairy Microbiology	1
	e. Agriculture Microbiology	1
	f. Industrial Microbiology	1
	g. Immunology	1
	h. Space Microbiology	1
	i. Nano Science	1

References:

1. Ahmed M. and Basumatary S. K. (2019). Applied Microbiology. MJP Publisher, Chennai, Tamil Nadu. India.
2. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0- 387-24143-2
3. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9

4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6
5. Bergey's Manual of Systematic Bacteriology. (2009). Volume Three: The Firmicutes. Part C: The Proteobacteria. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.). Springer. ISBN 978-0-387-95041-9
6. Beck R. W. (2000). A Chronology of Microbiology in Historical Context. United Kingdom: ASM Press.
7. Bender K. S., Buckley D. H., Stahl D. A., Sattley W. M. And Madigan M. T. (2017). Brock Biology of Microorganisms. E-Book, Global Edition. United Kingdom: Pearson Education.
8. Dubey H. C. (2004). A textbook of fungi, bacteria and Viruses. Vikas Publishing House Private Limited. New Delhi, India
9. Dubey R. C. and D. K. Maheshwary. (2012). A textbook of Microbiology. S Chand and Company. New Delhi, India
10. Goettel M. S. and Wilcks A. (2012). Beneficial Microorganisms in Agriculture, Food and the Environment: Safety Assessment and Regulation. United Kingdom: CAB International.
11. Jain A. and Jain P. (2019). Essentials of Microbiology. Elsevier- India.
12. Kanungo R. (2017). Ananthanarayan and Paniker's Textbook of Microbiology. 10th edition. Universities Press, Hyderabad, India
13. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGraw-Hill Higher Education.
14. Kumar S. (2015). Essentials of Microbiology. Jaypee Brothers, Medical Publishers Private. Limited, New Delhi, India.
15. Lagerkvist U. (2003). Pioneers of Microbiology and The Nobel Prize. Singapore: World Scientific Publishing Company.
16. Luria S. (2018). General Virology. Creative Media Partners, LLC. USA
17. Mehrotra R. S. (2009). Principles of Microbiology. India: McGraw-Hill Education (India) Private Limited.
18. Mishra B. B. and Nayak S. K. (2020). Frontiers in Soil and Environmental Microbiology. United States: CRC Press.
19. Pareek R. P. and Pareek N. (2019). Agricultural Microbiology. Scientific Publishers, Jodhpur, Rajasthan, India
20. Parija S. C. (2013). Textbook of Microbiology and Immunology - E-book. Elsevier Health Sciences, India
21. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume I. Himalaya Publishing House Private Limited, Pune, India.

22. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume II. Himalaya Publishing House, Private Limited, Pune, India
23. Prasad G. B., Bisen P. S. and Debnath M. (2012). Microbes: Concepts and Applications. Germany: Wiley.
24. Purohit S. S. (2006). Microbiology: Fundamentals and Applications. AGROBIOS, Jodhpur, Rajasthan, India
25. Reddy S. M., Girisham S. and Narendra Babu G. (2017). Applied Microbiology (Agriculture, Environmental, Food and Industrial Microbiology). Scientific Publishers, Jodhpur, Rajasthan, India
26. Santos D. M. (2021). Recent Advances in Microbiology. United States: Apple Academic Press
27. Schlegel H. G. (2005). General Microbiology. Cambridge University Press, United States.
28. Sherwood L., Woolverton C. J. and Willey J. (2016). Prescott's Microbiology. Singapore: McGraw-Hill Education.
29. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
30. Subba Rao N. S. (2016). Advances in Agricultural Microbiology. Netherlands: Elsevier Science.
31. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An Introduction. Twelfth edition. Pearson, London.
32. Verma D. K. (2019). Microbiology for Sustainable Agriculture, Soil Health, and Environmental Protection. United States: Apple Academic Press.
33. Woolverton C. J., Sherwood L. And Willey J. M. (2011). Prescott's Microbiology. United Kingdom: McGraw-Hill.

SEMESTER-I

Course code and title: USMR-112 Basic Techniques in Microbiology

Lectures: (Credits- 02)

Course Outcomes:

1. Students will be able to understand the needs and basics of techniques used in observing microbes.
2. Students will be aware of applications of basic techniques.
3. Students will learn sterilization and disinfection principles and procedures.

Credit	Topic	No. of Lectures (36)
Credit I	**1. Bacterial size, measurement and relevant techniques**	**1**
	2. Microscopy	
	a. Bright field microscopy and Dark field Microscopy	**4**
	● Electromagnetic spectrum of light, concepts of magnification, numerical aperture and resolving power. ray diagram ● Parts of microscope -condensers, eyepieces and objectives ● Concept of aberrations in lenses - spherical, chromatic	
	b. Principle, working and ray diagram of	**1**
	● Phase contrast microscope	
	● Fluorescence Microscopy	**1**
	● Electron Microscopy – TEM, SEM	**2**

	3. Staining Techniques: Concept and Need of staining	**1**
	a. Stain; Types (Basic and Acidic), Properties and role of Fixatives, Mordants, Decolourisers and Accentuators	**1**
	b. Monochrome staining and Negative (Relief) staining	**1**
	c. Differential staining - Gram staining and Acid-fast staining	**2**
	d. Special staining- Capsule (Maneval's method, Hiss method), Cell wall (Chance's method, Ringers's Method), Endospore (Dorners method, Schaeffer -Fulton's method), Flagella (Leifsons method, Loeffler's method), metachromatic granules (Alberts Method)	**4**
Credit II	**4. Sterilization and Disinfection**	
	a. Sterilization	
	● Physical Agents - Heat, Radiation, Filtration	**3**
	● Checking of efficiency of sterilization (Dry and Moist) – Biological and Chemical Indicators	**2**
	b. Disinfection:	
	● Chemical agents and their mode of action - Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds,	**4** **4**
	● Heavy metals, Alcohol, Dyes, Detergents and Ethylene oxide.	**1**
	● Characteristics of an ideal disinfectant ● Checking of efficiency of disinfectant - Phenol Coefficient (Rideal–Walker method)	**1**
	● Sanitization	**1**

References:

1. Debnath M., Prasad G. B. and Bisen P. S. (2012). Microbes: Concepts and Applications. Germany: Wiley.
2. Dokland T., Hutmacher D. W. and Schantz J. and Ng M. M. (2006). Techniques In Microscopy For Biomedical Applications. Singapore: World Scientific Publishing Company
3. Eliasa E. A., Samuelb O., Emmanuela N., Abrahama O. (2013). Evaluation of Efficacy of Disinfectants Using Standard Methods in Healthcare Facilities in Kogi state, Northcentral Nigeria. Asian Journal of Biomedical and Pharmaceutical Sciences. 03 (27): 34-38.
4. Hugo and Russell's Pharmaceutical Microbiology. (2008). Denyer S. P., Hodges N. A.,

Gorman S. P. and Gilmore B. F. (Editors). Germany: Wiley.
5. McDonnell G. E. (2020). Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance. United States: Wiley.
6. Murphy D. B. and Davidson M. W. (2012). Fundamentals of Light Microscopy and Electronic Imaging. Germany: Wiley.
7. Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). Microbiology: An Application based Approach. McGraw-Hill Education (India) Private Limited, New Delhi, India.
8. Pierce B. E. and Leboffe M. J. (2019). Microbiology: Laboratory Theory and Application: Essentials. United States: Morton Publishing.
9. Purohit S. S. (2006). Microbiology: Fundamentals and Applications. AGROBIOS, Jodhpur, Rajasthan, India
10. Rutala W. A. (2005). Disinfection, Sterilization, and Antisepsis: Principles, Practices, Challenges, and New Research. United States: Association for Professionals in Infection Control & Epidemiology (APIC), Incorporated.
11. Sharma K. (2007). Manual of Microbiology (Second Edition). ANE Books, New Delhi, India.
12. Sherwood L., Woolverton C. J. and Willey J. (2016). Prescott's Microbiology. Singapore: McGraw-Hill Education.
13. Singh R. P. (2012). Microbiology. Kalyani Publishers, New Delhi, India.
14. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An Introduction. Twelfth edition. Pearson, London.
15. Turner R. (2018). Essentials of Microbiology. United Kingdom: EDTECH. ISBN: 9781839473470
16. Wistreich G. A. (2007). Microbiology Perspectives: A Photographic Survey of the Microbial World. United Kingdom: Pearson Prentice Hall.

SEMESTER-I

Course code and title: USMRP-113 Practical Course based on USMR-111 and USMR-112

Lectures: (Credits- 1.5)

Course Outcomes:

1. Students will understand safety measures in microbiology laboratory.
2. Students will be Introduced to microbiology laboratory and common microbiology laboratory instruments.
3. Students will get acquainted with skills of aseptic culture technique
4. Students will observe microorganisms from natural samples.
5. Students will be able to prepare glassware and media for cultivation of microbes.

Expt. No.	Practical	No. of Practicals (14)
1	a. Safety measures and Good Laboratory Practices in microbiology laboratory. b. Preparation of SOP and demonstration of operations 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 of natural samples and 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. c. Aseptic culture Technique	**2**

4	Basic staining techniques: a. Monochrome staining b. Negative staining c. Gram staining d. Acid-fast staining (ZNCF Method)	**4**
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. (Demonstration)	**1**

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology And Biotechnology. New Age International, New Delhi, India
2. Baunthiyal M., Saxena J. and Ravi I. (2015). Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publishers, Jodhpur, Rajasthan, India.
3. Bisen P. S. (2014). Laboratory Protocols in Applied Life Sciences. United Kingdom: CRC Press.
4. Cappuccino J. and Welsh C. (2019). Microbiology: A Laboratory Manual, Loose Leaf Edition. United Kingdom: Pearson Education.
5. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
6. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International Private Limited, New Delhi, India.
7. Harley J. P. and Prescott L. (2020). Laboratory Exercises in Microbiology. Independently Published.
8. Karwa A.S., Rai M.K. and Singh H.B. (2012). Handbook of Techniques in Microbiology: A Laboratory Guide to Microbes. Scientific Publishers, Jodhpur, Rajasthan, India
9. Kumar V. (2012). Laboratory Manual of Microbiology. Scientific Publishers, Jodhpur, Rajasthan, India
10. Muralidhar S. (2019). Lippincott Illustrated Reviews Microbiology. Wolters Kluwer India Private Limited, Gurugram, Haryana, India.
11. Randhawa V. S. (2009). Practicals and Viva in Medical Microbiology. Second edition. India: Elsevier (A Division of Reed Elsevier India Pvt. Limited).
12. Sastry A. S. and Bhat S. K. (2017). Essentials of Practical Microbiology. Jaypee Brothers, Medical Publishers Private Limited, Pune, Maharashtra, India
13. Sharma K. (2007). Manual of Microbiology (Second Edition). ANE Books, New Delhi, India.

14. Solunke A. B., Wakte P. S., Hamde V. D. and Awasthi R. S. (2018). Manual of Methods for Pure Culture Study. Nirmal Publication. New Delhi (India).

SEMESTER-II

Course code and title: USMR-121 Bacterial Cell and Biochemistry

Lectures: (Credits- 02)

Course Outcomes:

1. Students will be able to understand bacterial cell structure and functions.
2. Students will have knowledge about different types of biomolecules and their functions.
3. Students will know about communication between bacteria.

Credits	Topic	No. of Lectures (36)
Credit I	**1. Ultrastructure of bacterial cell:**	**2**
	a. Cell wall (Gram positive, Gram negative)	**1**
	b. Concept of Mycoplasma, Spheroplast, protoplast, L-form	**2**
	c. Cell membrane	**1**
	d. Endospore (spore formation and stages of sporulation)	**1**
	e. Capsule	**1**
	f. Flagella	**2**
	g. Fimbriae and Pili	**2**
	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)	**5**
	2. Communication in bacteria through Quorum sensing	**1**

Credit II	**3. Chemical Basis of the cell** **I. Chemistry of Biomolecules:** Definition, classification, Structure and organization, functions **1) Carbohydrates:** a) Monosaccharides: Classification based on aldehyde and ketone groups; structure of Ribose, Deoxyribose, Glucose, Galactose and Fructose. b) Disaccharides: Glyosidic bond, structure of lactose and sucrose. c) Polysaccharides: Structure and types (Starch, glycogen, Peptidoglycan, chitin) **2) Lipids:** a) Simple lipids – Triglycerides, Fats and oils, waxes. b) Compound lipids – Phospholipid, Glycolipids c) Derived lipids – Steroids, Cholesterol **3) Proteins:** 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 4) **Nucleic acids:** a) DNA – structure and composition b) RNA – Types (m-RNA, t-RNA, r-RNA), structure and functions.	**2** **1** **1** **1** **1** **2** **1** **1** **1** **1** **2** **2**

References:

1. Atlas R. M. (1988, Digitized 2010). Experimental Microbiology: Fundamentals and Applications. United States: Macmillan.
2. Berry A. And Watson J. D. (2009). DNA: The Secret of Life. United States: Knopf Doubleday Publishing Group.
3. Bisen P.S. and Varma K. (2009). Handbook of Microbiology. CBS Publishers and Distributors, New Delhi. India
4. Biswas S. B. and Biswas A. (2006) Introduction to viruses. Vikas Publishing House Private Limited, New Delhi, India

5. Dubey R. C. and D. K. Maheshwary. (2012). A textbook of Microbiology. S Chand and Company. New Delhi, India
6. Kapoor K. K., Tauro P. and Yadav K. S. (2016). An Introduction to Microbiology. New Age International (P) Limited, New Delhi, India.
7. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGraw-Hill Higher Education.
8. Miller A. D. and Tanner J. (2013). Essentials of Chemical Biology: Structure and Dynamics of Biological Macromolecules. Germany: Wiley.
9. Parasher Y. K. (2006). Modern Microbiology. Campus Books International, New Delhi, India.
10. Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). Microbiology: An Application based Approach. McGraw-Hill Education (India) Private Limited, New Delhi, India.
11. Roush R., Wise J. and Fowler, S. (2018). Concepts of Biology. Hong Kong: Samurai Media Limited.
12. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume I. Himalaya Publishing House Private Limited, Pune, India.
13. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume II. Himalaya Publishing House, Private Limited, Pune, India
14. Purohit S. S. (2006). Microbiology: Fundamentals and Applications. AGROBIOS, Jodhpur, Rajasthan, India
15. Saenger W. (2013). Principles of Nucleic Acid Structure. United States: Springer New York.
16. Singh R. P. (2012). Microbiology. Kalyani Publishers, New Delhi, India
17. Singh R. P. and Singh B. D. (2009). Microbial Physiology and Microbial Genetics: (Microbiology). Kalyani Publishers, New Delhi, India.
18. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
19. Melissa B. Miller and Bonnie L. Bassler QUORUM SENSING IN BACTERIA Annu. Rev. Microbiol. 2001. 55:165–99
20. Tsai C. S. (2007). Biomacromolecules: Introduction to Structure, Function and Informatics. Germany: Wiley.
21. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An Introduction. Twelfth edition. Pearson, London.
22. Yadav M. (2017). Microbiology. Discovery Publishing House, New Delhi, India. ISBN 13: 9788171417315

SEMESTER-II

Course code and title: USMR-122: Microbial cultivation and growth

Lectures: (Credits- 02)

Course Outcomes:

1. Students will have knowledge about microbial nutritional classification and microbial cultivation media.
2. Students will learn about the technique of isolation and enumeration of microbes.
3. Students will understand the bacterial growth kinetics and measurements.

Credit	Topic	No. of Lectures (36)
Credit I	**1. Cultivation of Microorganisms:**	
	a. Chemical composition of typical bacterial cell, Nutrition and Nutritional requirements, classification based on nutrition.	**4**
	b. Design and preparation of culture media: Common ingredients of media, types of culture media (Complex, synthetic, semi-synthetic, etc.)	**3**
	c. Concept of Enrichment, Pure Culture, Isolation of culture by streak plate, pour plate, spread plate.	**3**
	d. Methods for cultivating photosynthetic, extremophilic and chemo-lithotrophic bacteria, anaerobic bacteria, algae, fungi, actinomycetes and viruses.	**4**
	e. Maintenance of bacterial and fungal cultures using different techniques.	**3**
	f. Culture collection centres and their role.	**1**

Credit II	**2. Bacterial growth:**	
	a. Kinetics of bacterial growth	**3**
	Binary division, budding, fragmentation, Exponential growth model, calculation of generation time and specific growth rate	**2**
	b. Growth curve- phases, Diauxic growth and Synchronous growth	**4**
	c. Batch culture and Continuous culture, Concept of fermentation, yield- biomass and product	
	d. Measurement of bacterial growth- Microscopic methods -Direct microscopic count, counting cells using Neubauer chamber	**2**
	e. Plate counts (Total viable count)	**2**
	f. Turbidometric methods and biomass (Dry mass)	**2**
	g. Factors affecting bacterial growth [pH, Temperature, Solute Concentration (Salt and Sugar)] and Heavy metals.	**3**

References:

1. Atlas R. M. (2005). Handbook of Media for Environmental Microbiology. United States: Taylor and Francis.
2. Atlas R. M. (2010). Handbook of Microbiological Media. Ukraine: Taylor and Francis.
3. Bisen P.S. and Varma K. (2009). Handbook of Microbiology. CBS Publishers and Distributors, New Delhi. India
4. Dubey H. C. (2004). A textbook of fungi, bacteria and Viruses. Vikas Publishing House Private Limited. New Delhi, India
5. Dubey R. C. and D. K. Maheshwary. (2012). A textbook of Microbiology. S Chand and Company. New Delhi, India
6. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
7. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International Private Limited, New Delhi, India.
8. Kapoor K. K., Tauro P. and Yadav K. S. (2016). An Introduction to Microbiology. New Age International (P) Limited, New Delhi, India.

9. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGraw-Hill Higher Education
10. Parasher Y. K. (2006). Modern Microbiology. Campas Books International, New Delhi, India
11. Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). Microbiology: An Application based Approach. McGraw-Hill Education (India) Private Limited, New Delhi, India.
12. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume I. Himalaya Publishing House Private Limited, Pune, India.
13. Powar C. B. and Daginawala H. I. (2005). General microbiology Volume II. Himalaya Publishing House, Private Limited, Pune, India
14. Purohit S. S. (2006). Microbiology: Fundamentals and Applications. AGROBIOS, Jodhpur, Rajasthan, India
15. Singh R. P. (2012). Microbiology. Kalyani Publishers, New Delhi, India Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
16. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: an Introduction. Twelfth edition. Pearson, London.
17. Yadav M. (2017). Microbiology. Discovery Publishing House, New Delhi, India. ISBN 13: 9788171417315

SEMESTER-II

Course code and title: USMRP-123 Practical Course based on USMR-121 and USMR-122

Lectures: (Credits- 1.5)

Course Outcomes:

1. Students will be able to prepare microbial cultivation media and acquire skills of isolations techniques.
2. Students will be able to stain bacteria by special techniques.
3. Students will be aware of preservation and maintenance of microbes in laboratory conditions.

Expt No.	Topics	No. of practical (14)
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:** **1.** Cell wall staining (Chance's method) **2.** Capsule staining (Manevals method) **3.** Endospore staining (Schaeffer -Fulton's method) **4.** Metachromatic granules staining (Albert's Method)	1 1 1 1
3	**Preservation of cultures on:** Slants, glycerol stocks Demonstration of lyophilization and lyophilized cultures.	1
4	**Isolation of bacteria:** Streak plate technique (Colony characteristics)	1

5	**Enumeration of bacteria from fermented food / soil / water by:** i. Spread plate method ii. Pour plate method	2
6	**To study the effect of different parameters on growth of *Bacteria*:** i. pH, temperature, sodium chloride concentration, Oxygen conditions. ii. Study of oligodynamic action of heavy metal	2
7	**Growth curve of bacteria**	1

References:

1. Arora B. and Arora D. R. (2020). Practical Microbiology. CBS Publishers and Distributors, New Delhi, India.
2. Atlas R. M. (2010). Handbook of Microbiological Media. Ukraine: Taylor and Francis.
3. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
4. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International Private Limited, New Delhi, India.
5. Jain A., Agarwal J. and Venkatesh V. (2018). Microbiology Practical Manual. 1st Edition. E-Book. Elsevier Health Sciences, India.
6. Karwa A. S., Rai M. K. and Singh H. B. (2012). Handbook of Techniques in Microbiology: A Laboratory Guide to Microbes. Scientific Publishers, Jodhpur, Rajasthan, India
7. Kumar V. (2012). Laboratory Manual of Microbiology. India: Scientific Publishers.
8. Panjarathinam R. (2008). Practical Medical Microbiology. Jaypee Brothers, Medical Publishers Private Limited, India
9. Prasad M. M. and Roy A. K. (2009). Laboratory Manual of Microbiology. New India Publishing Agency. New Delhi, India
10. Proctor D. B., Niedzwiecki B., Garrels M., Weaver P. A., Pepper J. and Mills H. (2019). Kinn's The Clinical Medical Assistant - E-Book: An Applied Learning Approach. United States: Elsevier Health Sciences.
11. Sandle T. (2013). Sterility, Sterilisation and Sterility Assurance

for Pharmaceuticals: Technology, Validation and Current Regulations. United Kingdom: Elsevier Science.

12. Sastry A. S. and Bhat S. K. (2017). Essentials of Practical Microbiology. Jaypee Brothers, Medical Publishers Private Limited, New Delhi, India
13. Tambwekar S. (2015). Handbook of Quality Assurance in Laboratory Medicine. Wolters kluwer India Pvt Ltd.
14. Vasanthakumari. (2009). Practical Microbiology. B. I. Publications Private Limited, New Delhi, India.

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