



**Maharashtra Education Society's  
Abasaheb Garware College, Pune  
(Autonomous)**

(Affiliated to Savitribai Phule Pune University, Pune)

Syllabus  
**Three Year B.Sc. Degree Program**  
in  
**Microbiology**  
(Faculty of Science & Technology)

**Syllabi under autonomy  
S. Y. B. Sc. (Microbiology)**

**Choice Based Credit System Syllabus**

**To be implemented from Academic Year 2023-2024**

**Titles of courses in S. Y. B. Sc. Microbiology**

<b>Semester</b>	<b>Paper Code</b>	<b>Paper</b>	<b>Paper Title</b>
III	USMR- 231	I	Medical Microbiology and Immunology
	USMR -232	II	Bacterial Physiology and Fermentation Technology
	USMRP-233	III	Practical based on USMR-231 and USMR-232
IV	USMR- 241	I	Bacterial Genetics
	USMR- 242	II	Air, Water and Soil Microbiology
	USMRP -243	III	Practical based on USMR-241 and USMR-242

<b>Subject /Paper Code</b>	<b>Subject/Paper Title</b>	<b>Subject type (theory/practical/other)</b>	<b>Credits Allotted</b>	<b>Type Optional/ compulsory</b>	<b>Medium Description (English/Hindi/Marathi)</b>	<b>FY/SY/TY BA/BSc MA/MSc part1/part2 Mlib/Blib</b>	<b>Semester (I/II/III/IV/V/VI)</b>	<b>Lectures allotted</b>
USMR-231	Medical Microbiology and Immunology	Theory	2	Compulsory	English	SYBSc	III	36
USMR -232	Bacterial physiology and Fermentation Technology	Theory	2	Compulsory	English	SYBSc	III	36
USMRP-233	Practical based on USMR-231 and USMR 232	Practical	2	Compulsory	English	SYBSc	III	78
USMR-241	Bacterial Genetics	Theory	2	Compulsory	English	SYBSc	IV	36
USMR-242	Air, Water and Soil Microbiology	Theory	2	Compulsory	English	SYBSc	IV	36
USMRP-243	Practical based on USMR-241 and USMR-242	Practical	2	Compulsory	English	SYBSc	IV	78

**Evaluation:**

Semester	Paper code	Paper	Paper title	Credits	Lectures/week		Evaluation		
					Th	Pr	In	Ex	T
III	USMR-231	1	Medical Microbiology and Immunology	2	3		15	35	50
	USMR -232	2	Bacterial physiology and Fermentation Technology	2	3		15	35	50
	USMRP-233	3	Practical based on USMR-231 and USMR 232	2		4	15	35	50
IV	USMR-241	1	Bacterial Genetics	2	3		15	35	50
	USMR-242	2	Air, Water and Soil Microbiology	2	3		15	35	50
	USMRP-243	3	Practical based on USMR-241 and USMR-242	2		4	15	35	50

**SEMESTER-III****Course code and title: USMR –231: Medical Microbiology and Immunology****Lectures: 36 (Credits- 2)****Course Outcomes:**

1. Students will understand different terminologies routinely used in Medical microbiology and Immunology
2. Students will be able to learn about different characteristics of microorganisms which make them pathogenic and their use in medical diagnosis.
3. A much better understanding about the human immune system and its cellular defenses will be provided.

<b>Credit</b>	<b>Topic</b>	<b>No. Of Lectures</b>
<b>Credit I</b>	<b>Medical Microbiology</b>	<b>18</b>
<b>1</b>	Definitions: Incubation period, Viability, Susceptibility, Pathogenicity, Virulence, Pathogenesis, Lab diagnosis, Epidemic, Sporadic, Endemic, Pandemic	02
<b>2</b>	Study of following pathogens with respect to: Classification, Morphological, Cultural and Biochemical characters, Antigenic structure, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylactic and therapeutic measures: <b>Bacteria:</b> a) <i>Escherichia coli</i> b) <i>Staphylococcus aureus</i> <b>Fungi:</b> a) <i>Candida</i> b) <i>Trichophyton rubrum</i> <b>Virus:</b> a) Influenza	10
<b>3</b>	<b>Introduction to Chemotherapy:</b> i. General principles of chemotherapy ii. Selective toxicity, Bioavailability, MIC, MBC, LD50 iii. Concept of antagonism and synergism in drug administration iv. Antibiotic misuse/antibiotic overuse v. Concept of drug resistance (e.g. MRSA, ESBL)	06
<b>Credit II</b>	<b>Immunology</b>	<b>18</b>
<b>4</b>	Immunity: Definition, types (innate and acquired, active and passive, humoral and cell mediated)	02

5	Cytology and functions of microphages and macrophages Cytology and functions of lymphoid cells Introduction to antigen presenting cells	05
6	General characters and definition of antigens Definition, structure and functions of antibodies	02
7	ABO and Rh blood group systems Bombay blood group Types of blood group systems – ABO, Rh, Bombay Introduction to complement system and Interferons	06
8	<b>Active and Passive Immunization</b> i. Active Immunization -Whole organism vaccines a) Attenuated vaccines b) Inactivated Vaccines ii. Passive Immunization Transfer of preformed antibodies iii. Latest Immunization schedule in India	03

**Suggested references:**

1. Kanungo Reba. (2017). Ananthanarayan and Paniker's Textbook of Microbiology. Tenth edition. The Orient Blackswan Publisher. ISBN-13: 978-9386235251
2. Collins C. H., Lyne P. M., Grange J. M. and Falkinham J. O. III. (Editors). (2004). Collins and Lyne's Microbiological Methods. 8th edition. Arnold, London; Oxford
3. Finch R., Greenwood D., Whitley R. and Norrby S. R. (2010) Antibiotic and Chemotherapy. 9<sup>th</sup> Edition. Elsevier. ISBN: 9780702040641
4. Dulbecco R., Eisen H. N. and Davis B. D. (1990). Microbiology. United States: Publisher -Lippincott. ISBN: 9780608072432
5. Dey N. C., Dey T. K. and Sinha D. (2013). Medical Bacteriology Including Medical Mycology and AIDS. 17<sup>th</sup> Edition. New Central Book Agency (P) Ltd (Publisher). India
6. Kindt T. J., Goldsby R. A. and Osborne B. A. (2007). Kuby Immunology. 6th Ed. W. H. Freeman and Co., New York.
7. MacFaddin J. F. (1985). Media for Isolation-Cultivation-Identification –Maintenance of Medical Bacteria. Vol. I. Williams and Wilkins, Baltimore
8. MacFaddin J. F. (2000). Oxidation- Fermentation Test. Biochemical Tests for Identification of Medical Bacteria. 3<sup>rd</sup> ed. Philadelphia: Lippincott Wilkins and Williams. 379-387. B, III
9. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257
10. Mukred A. M., Hamid A. A., Hamzah A. and Wan Mohtar Wan Yusoff W. M. W. (2008). Growth Enhancement of Effective Microorganisms for Bioremediation of Crude Oil Contaminated Waters. Pakistan Journal of Biological Sciences.11: 1708-1712.
11. Pathak S. S. and Palan V. (1997). Immunology-Essential and Fundamental, Preen

- Publications Bombay.
12. Public Health England. (2019). Oxidation/fermentation of glucose test. UK Standards for Microbiology Investigations. TP 27 Issue 4. <https://www.gov.uk/uk-standards-formicrobiology-investigations-smi-quality-and-consistency-in-clinical-laboratories>
  13. Roitt Evan, Brostoff J., Male D. (1993) Immunology. 6<sup>th</sup> Edition. Mosby and Co. London.
  14. Roitt I. M. (1988). Essentials of Immunology, ELBS, London.
  15. Roitt M. (1984). Essentials of Immunology. P. G. Publishers Private Limited, New Delhi.
  16. Roth J. A., Bolin C., Brogden K. A., Chris Minion K. F. and Wannemuehler M. J. (1995). Virulence mechanisms of bacterial pathogens. Second edition. American Society for Microbiology. ISBN-13: 978-1555810856
  17. Schuenke S. (1997). Medical Microbiology. Fourth edition. University of Texas Medical Branch of Galvesion. Samuel Baron (Editor). ASIN: B008UYPLIO
  18. Champoux J. J., Neidhardt F. C., Drew W. L. and Plorde J. J. (2004). Sherris Medical Microbiology: An Introduction to infectious diseases. 4<sup>th</sup> edition. Ryan K. J. and Ray C. G. (Editors). McGraw-Hill Companies. DOI: 10.1036/0838585299
  19. Shrivastava M., Navaid S., Peethambarakshan A., Agrawal K. and Khan A. (2015). Detection of rare blood group, Bombay (Oh) phenotype patients and management by acute normovolemichemodilution. Asian journal of transfusion science. 9(1):74–77
  20. Standards Unit. National Infection Service. PHE Bacteriology – Test Procedures. TP. 27(4): Issue date: 16.01.19. 1-14
  21. Stites D. P., Stobo J. D., Fudenberg H. H. and Wells J. V. (1982). Basic and Clinical Immunology. 4<sup>th</sup> Edition. Lange Medical Publications, Maruzen Asia Pvt. Ltd., Singapore.
  22. Gangal S. and Sontakke S. (2013). Textbook of Basic and Clinical Immunology. Universities Press Private limited. Available also at Orientblackswan, India. ISBN: 9788173718298
  23. Talwar G. P. (1983). Handbook of Immunology. Vikas Publishing Pvt. Ltd. NewDelhi.
  24. Paul W. E. (2003): Fundamental Immunology. 5<sup>th</sup> edition. Lippincott Williams and Wilkins Publishers. ISBN: 9780781735148
  25. Joklik W. K., Willett H. P., Amos D. B. and Wilfert C. M. 1995). Zinsser's Microbiology. 20th Edition. Appleton and Lange Publisher. ISBN-13: 978- 0838599839
  26. Zajic J. E. and Supplisson B. (1972). Emulsification and degradation of “Bunker C” fuel oil by microorganisms. Biotechnol. Bioeng. 14: 331-343.

**SEMESTER-III****Course code and title: USMR -232: Bacterial Physiology and Fermentation Technology****Lectures: 36 (Credits- 2)****[1credit=15hrsx60mins=900 mins/50mins=18 lectures]****Course Outcomes:**

1. To allow students to appreciate and apply basic knowledge of Microbiology for its use in fermentation science
2. Students will understand the meaning and scope of Microbiology with respect to bacterial physiology.

<b>Credit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Credit I</b>	<b>Bacterial Physiology</b>	<b>(18)</b>
<b>1</b>	<b>Enzymes</b>	
	Introduction to Enzymes: Properties of enzymes, Nature of active site, Structure of active site, commonly occurring amino acids at active site, Ribozymes, coenzymes, apoenzymes, prosthetic group and cofactors.	2
	Nomenclature and classification as per IUB (up to class level).	2
	Models for catalysis– a) Lock and key b) Induced fit Concept of Transition state.	1
	Effect of pH and temperature, substrate concentration and enzyme concentration, activators and inhibitors of enzyme	3
<b>2</b>	<b>Physiology of bacteria</b>	
	Definitions of Metabolism, catabolism, anabolism, respiration and fermentation	1
	Metabolic pathways (with structures)	
	a) Embden Meyerhof Parnas pathway (Glycolysis)	2
	b) Hexose monophosphate pathway	2
	c) EntnerDoudoroff pathway	1
	d) Phosphoketolase pathway (Pentose and hexose)	1
e) TCA cycle (with emphasis on amphibolism) and Glyoxylate bypass	2	
f) Gluconeogenesis and its significance	1	
<b>Credit II</b>	<b>Fermentation Technology</b>	<b>(18)</b>
<b>3</b>	Concept of fermentation technology	
	i. Microbial biomass- based fermentation (Biofertilizer, biopesticide and Probiotics)	
	ii. Production of Primary metabolites (Organicacids, aminoacids, vitamins and enzymes)	4
	iii. Production of Secondary metabolites (Penicillin)	
	iv. Production of recombinant products (insulin)	
<b>4</b>	Strains of industrially important microorganisms	5



	i. Desirable characteristics of industrial strain ii. Principles and methods of primary and secondary screening iii. Master, working and seed culture; development of inoculum iv. Preservation and maintenance of industrial strains.	
5	Design of a Fermenter (typical CSTR Continuous stirred Tank Reactor): Different parts and their working	2
6	Monitoring of different fermentation parameters (Temperature, pH, aeration, agitation, foam)	2
7	Types of fermentations: Batch, continuous and Fed batch	2
8	Media for industrial fermentations: Constituents of media (Carbon source, nitrogen source, amino acids, vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers)	3

### Suggested references:

1. BIOTOL Series. (1993). Biotechnology by open learning series. Defense Mechanisms. Butterworth and Heinemann Ltd., Oxford
2. Casida L. E. J. R. (2016). Industrial Microbiology. New Age International Private Limited. ISBN-9788122438024
3. Conn E. E., Stumpf P. K., Bruening G., Doi R. Y. (1987). Outlines of Biochemistry. 5<sup>th</sup> Edition, John Wiley and Sons, New Delhi. (Unit I & II)
4. Madigan M. T., Martinko J. M. and Brock T. D. (2006). Brock's Biology of Microorganisms. Pearson Prentice Hall, Upper Saddle River.
5. Moat A. G. and Foster J. W. (1988). Microbial Physiology. 2<sup>nd</sup> Edition. John Wiley and Sons New York.
6. Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry. 8<sup>th</sup> edition. MacMillan Worth Pub. Co. New Delhi. ISBN: 9781319228002
7. Patel A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13-9789385750267
8. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume 1: Microbial Processes. Academic Press, New York. ISBN: 978-0-12-551501
9. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume II: Fermentation Technology (2<sup>nd</sup> Edition). Academic Press. ISBN: 9781483268279
10. Prescott L. M., Harley J. P. and Klein D. A. (2005). Microbiology. 6<sup>th</sup> Edition. MacGraw Hill Companies Inc. (Unit II)
11. Reed G. (Editor). (1982). Prescott and Dunn's Industrial Microbiology. Westport, CT, AVI Publishing Co Inc.
12. Stanbury P. F., Whitaker A. and Hall S. J. (2016). Principles of Fermentation Technology. 3<sup>rd</sup> Edition. Butterworth-Heinemann. ISBN: 9780080999531
13. Voet D. and Voet J. G. (1995). Biochemistry. 2<sup>nd</sup> Edition. John Wiley & Sons. New York. ISBN 0-471-58651-X



**Suggested references:****Experiment 1. Measurements of cell dimension by micrometry:**

1. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
2. Gunasekaran P. (2007). Laboratory Manual In Microbiology. New Age International (P) Limited New Delhi, India
3. Muskan K. and Patil U. K. (2009). Essentials of Biotechnology. I. K. International Publishing House Private Limited, New Delhi, India.
4. Saxena J., Baunthiyal M. and Ravi I. (2015). Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publishers, New Delhi, India

**Experiment 2. Cell Wall Staining**

1. Saxena J., Baunthiyal M. and Ravi I. (2015). Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publishers, New Delhi, India

**Experiment 3. Blood grouping:**

2. Godkar D. P. (2003). Textbook of Medical Laboratory Technology. Bhalani Publishing House, New Delhi, India.
3. Mukherjee K. L. (2013). Medical Laboratory Technology. Second Edition. Volume III. McGraw-Hill Companies, India.

**Experiment 4. Isolation and identification of pathogens from clinical samples:**

1. Mac Faddin J. F. (2000). Biochemical Tests for Identification of Medical Bacteria. United Kingdom: Lippincott Williams and Wilkins.
2. Randhawa V. S., Mehta G. and Sharma K. B. (2009). Practicals and Viva in Medical Microbiology. Second Edition. Elsevier (A Division of Reed Elsevier India Pvt. Limited).
3. Verhaegen J. and Heuck C. C. (Editors). (2003). Basic Laboratory Procedures in Clinical Bacteriology. Second Edition. Switzerland: World Health Organization.

**Experiment 4.b.i. Sugar utilization test: Minimal salt Medium (MSM with 1% sugar):**

1. Mukred A. M., Hamid A. A., Hamzah A. and Wan Yusoff W. M. (2008). Enhancement of Biodegradation of Crude Petroleum-Oil in Contaminated Water by the Addition of Nitrogen Sources. Pakistan Journal of Biological Sciences, 11: 2122-2127.
2. Mahalingam B. L., Karuppan M. and Manickam V. (2013). Optimization of Minimal Salt Medium for Efficient Phenanthrene Biodegradation by Mycoplasma sp. MVMB2 Isolated from Petroleum Contaminated Soil Using Factorial Design Experiments. CLEAN - Soil, Air, Water. 41(1): 51-59. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim

**Experiment 4.b. ii. Sugar fermentation test:- Phenol Red Broth Base:**

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India
2. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
3. Mac Faddin J. F. (2000). Biochemical Tests for Identification of Medical Bacteria. United Kingdom: Lippincott Williams and Wilkins.

**Experiment 4.b. iii. Triple sugar Iron Agar:**

1. Jain A., Agarwal J. and Venkatesh V. (2018). Microbiology Practical Manual.1st Edition. E-Book. Elsevier Health Sciences, India.
2. Mac Faddin J. F.(2000). Biochemical Tests for Identification of Medical Bacteria.UnitedKingdom:Lippincott Williams and Wilkins.
3. Randhawa V. S., Mehta G. and Sharma K. B. (2009). Practicals and Viva in Medical Microbiology.Second Edition.Elsevier (A Division of Reed Elsevier India Pvt. Limited).

**Experiment 4.b. iv. IMViC test:**

1. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
2. Jain A., Agarwal J. and Venkatesh V. (2018). Microbiology Practical Manual.1st Edition. E-Book. Elsevier Health Sciences, India.
3. Randhawa V. S., Mehta G. and Sharma K. B. (2009). Practicals and Viva in Medical Microbiology.Second Edition.Elsevier (A Division of Reed Elsevier India Pvt. Limited).
4. Verma A. S., Das S., and Singh A. (2014). Laboratory Manual for Biotechnology. S Chand and Company Limited, New Delhi, India

**Experiment 4. b. v. Enzyme detection:**

1. Carroll K.C., Pfaller M. A., Landry M. L., McAdam A. J., Patel R., Richter S. S. and Warnock D. W. (Editors). (2019). Manual of Clinical Microbiology.2 Volume Set.12th Edition. John Wiley, USA
2. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
3. Goldman E. and Green L. H. (2008). Practical Handbook of Microbiology. United States: CRC Press.
4. Leber A. L. (2020). Clinical Microbiology Procedures Handbook. United States: Wiley.
5. Verhaegen J. and Heuck C. C.(Editors).(2003). Basic Laboratory Procedures in Clinical Bacteriology.SecondEdition.Switzerland:World Health Organization.

**Experiment 5. Primary screening of industrially important organisms:**

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India
2. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
3. Gunasekaran P. (2007). Laboratory Manual in Microbiology.New Age International Private Limited, New Delhi, India.

**SEMESTER-IV****Course code and title: USMR- 241 Bacterial Genetics****Lectures: 36 (Credits- 2)****Course Outcomes:**

1. Students will be able to understand the classical and molecular concepts of genetics.
2. Students will gain knowledge about mutations and plasmids and will be able to correlate their importance with applied molecular biology.

<b>Credit</b>	<b>Topic</b>	<b>No. of Lectures</b>
<b>Credit I</b>		<b>(18)</b>
<b>1</b>	Experimental evidences suggesting nucleic acid as genetic material: a. Discovery of transforming material (hereditary material): b. Griffith's experiment c. Avery and MacLeod experiment d. Gierer and Schramm experiment e. Fraenkel-Conrat and Singer experiment (TMV virus) f. Hershey and Chase experiment	07
<b>2</b>	Types of nucleic acids (DNA and RNA)	01
<b>3</b>	Structure of DNA: a. Structure of Nitrogen bases, Nucleoside, Nucleotide and polynucleotide chain b. Bonds involved in DNA structure c. Different forms of DNA	02
<b>Credit II</b>		<b>(18)</b>
<b>4</b>	Prokaryotic DNA replication : a. Models of DNA replication (Conservative, semi-conservative and Dispersive) b. Meselson and Stahl's experiment (semi-conservative) d. Enzymes, proteins and other factors involved in DNA replication. e. Steps involved in DNA replication f. Modes of DNA replication - rolling circle mechanism, theta and linear DNA replication	08
<b>5</b>	Concept and characteristics of Genetic code	02

6	<p>Mutations and reversions          Concept of Mutation and Types of mutations: Nonsense, Missense, Silent, Conditional lethal - temperature sensitive, Amber, Reverse, suppressor</p> <p>a. Spontaneous Mutation</p> <ol style="list-style-type: none"> <li>i. Discovery of spontaneous mutation (Fluctuation test)</li> <li>ii. Mechanism of spontaneous mutation</li> <li>iii. Isolation of Mutants: Replica plate technique</li> </ol> <p>b. Concept of Induced Mutations</p> <ol style="list-style-type: none"> <li>i. Base pair substitution (Transitions, Transversions), Insertions and deletions-Frame / Phase shift mutations</li> <li>ii. Physical Mutagenic agent: UV and X-ray</li> <li>iii. Chemical mutagenic agents</li> <li>iv. Base analogues (2 amino purine, 5 bromouracil),</li> <li>v. HNO<sub>2</sub>, Alkylating agents</li> <li>vi. Intercalating agents (EtBr, acridine orange)</li> </ol>	14
7	<p>Plasmid genetics</p> <ol style="list-style-type: none"> <li>i. Types of plasmids</li> <li>ii. Properties of plasmid</li> <li>iii. Plasmid replication</li> </ol>	02

**Suggested references:**

1. Brooker R. J. (2012). Genetics: Analysis and Principles. 4th edition. McGraw- Hill-Publication
2. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P. (2008). Molecular Biology of the Cell.5th Edition. Garland Science. Taylor and Francis. ISBN: 978-0-8153-4105-5
3. Malacinski G. M. (2005). Freidfelder's Essentials of Molecular Biology. 4th Edition. Jones and Bartlett Publishers, Inc
4. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). Principles of Genetics.8th edition.John Wiley and Sons Publication. ISBN-13: 9788126510436
5. Hayes W. (2nd Edition). (1968). Genetics of Bacteria and their Viruses. Oxford-Edinburgh: Blackwell Scientific Publications.
6. Watson J.D., Baker, T.A., Bell, S.P., Gann A., Levine M. and Losick R. (2014). Molecular Biology of the gene.7th edition. Pearson. ISBN: 9780321762436
7. Krebs J., Kilpatrick S. T., Goldstein E. S. (Editors). Lewin's GENES X (2011). 10th Edition.Sudbury, Mass: Jones and Bartlett, c2011

8. Lodish H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., Martin K. C., Yaffe M. and Amon A. (2021). Molecular Cell Biology, 9th Edn. Macmillan Learning. ISBN: 9781319208523

9. Pawar and Daginawala. General Microbiology. Vol.I and vol II.1st Edition.

Himalaya Publishing House, Mumbai

10. Primrose S. B. (2002) .Principles of Gene Manipulation. 6th Edition. Oxford: Blackwell Scientific Publications

11. Russel P. J. (2000). Fundamentals of Genetics. Publisher: Benjamin/Cummings. ISBN:9780321036261

12. Russel P. J. (2010). iGenetics: A Molecular Approach. 3rd Edition. Benjamin Cummings. ISBN: 9780321569769

13. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.

14. Strickberger M. W. (2012). Genetics. 3rdEdition. New Delhi: PHI Learning Gardner

**SEMESTER-IV****Course code and title: USMR-242: Air, Water and Soil Microbiology****Lectures: 36 (Credits- 2)****[1credit=15hrsx60mins=900 mins/50mins=18lectures]****Course Outcomes:**

1. Students will be able to understand importance of microorganisms with respect to air, water and soil microbiology
2. Students will gain insight about the applications of microorganisms in the field of water and soil microbiology.

<b>Credit I</b>	<b>Air Microbiology and Water Microbiology</b>	<b>(18)</b>
<b>1</b>	<b>i. Air Microbiology</b>	
	a. Air flora <ul style="list-style-type: none"> <li>• Transient nature of air flora</li> <li>• Droplet, droplet nuclei and aerosols</li> </ul>	1
	b. Methods of Air sampling and types of air samplers <ul style="list-style-type: none"> <li>• Impaction on solids</li> <li>• Impingement in liquid</li> <li>• Sedimentation</li> <li>• Centrifugation</li> </ul>	3
	c. Air sanitation: Physical and chemical methods	2
	d. Air borne infections	1
<b>2</b>	<b>ii. Water Microbiology</b>	
	a. Types of water: surface, ground, stored, distilled, mineral and de-mineralized water	1
	b. Recommended Bacteriological standards of Water Quality <ul style="list-style-type: none"> <li>• Maharashtra Pollution Control Board (MPCB) Main Functions of MPCB Water quality standards for best designated usages</li> <li>• Central Pollution Control Board (CPCB) Main Functions of CPCB Designated Best Use Water Quality Criteria</li> </ul>	1
	c. Water purification methods	2
	d. Water borne Infections	1



<b>Credit II</b>	<b>Soil Microbiology</b>	<b>(18)</b>
	a. Rhizosphere microflora and its role in the rhizosphere	2
	b. Role of microorganisms in composting and humus formation	2
	c. Biofertilizers: Bacterial, Cyanobacterial	2
	d. Biocontrol agents: Bacterial, Viral, Fungal	2
	e. Brief account of microbial interactions Symbiosis, Neutralism, Commensalism, Competition, Ammensalism, Synergism, Parasitism and Predation	6
	f. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen	4

## Suggested references:

1. Aithal S.C. and Kulkarni N.S. (2015). Water microbiology ~ an Indian perspective. Published by Himalaya Publishing House, 1st Edition. ISBN: No.: 978-93-5202-129-1.
2. Dube H.C. and Bilgrami K.S. (1976). Textbook of modern pathology. Vikas publishing house. New Delhi.
3. Dubey R.C. and Maheswari D.K. Textbook of Microbiology. S. Chand Publishing. ISBN: 9788121926201
4. Frobisher M. (1974). Fundamentals of Microbiology. 9<sup>th</sup> Edition. Saunders, Michigan University Press. ISBN: 9780721639222
5. Ingraham C.A. and Ingraham J.L. (2000). Introduction to Microbiology. United Kingdom: Brooks/Cole.
6. Lim D. V. (1989). Microbiology. 2<sup>nd</sup> Edition. West Publishing Company. ISBN: 9780314262066
7. Madigan M.T., Thomas Brock T., Martinko J., Clark D.P. and Paul D.P. (2009). Brock's Biology of Microorganisms. Pearson/Benjamin Cummings. ISBN: 9780132324601
8. Martin A. (1977). An Introduction to Soil Microbiology. 2<sup>nd</sup> edition. John Wiley & Sons Inc. New York & London.
9. Martin A. Introduction to Soil Microbiology. (1961). John Wiley & Sons, New York and London publication
10. MPCB, CPCB, BIS and WHO websites guidelines for drinking water quality
11. Pawar C.B. and Daginawala H.F. (1982). General Microbiology. Vol. I and II. 1<sup>st</sup> Edition. Himalaya Publishing House, Mumbai. ISBN: 9789350240892 and ISBN 9789350240908
12. Pelzar M.J., Chan E.C.S. and Krieg N.R. (1986). Microbiology. 5<sup>th</sup> Edition. McGraw-Hill Publication
13. Prescott L.M., Harley J.P. and Klein D.A. (2006). Microbiology. 6<sup>th</sup> Edition. McGraw Hill Higher Education. ISBN-13: 978-0-07-295175-2
14. Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi.
15. Salle A.J. (1971). Fundamental Principles of Bacteriology. 7<sup>th</sup> Edition. Tata MacGraw Publishing Co.
16. Schlegel H.G. (1993). General Microbiology. 8<sup>th</sup> Edition. Cambridge University Press

17. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
18. Subba Rao N. S. (1977). Soil Microbiology. 4th Edition. Oxford and IBH Publishing Co. Pvt. Ltd.
19. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An Introduction 12th Edition, Pearson. ISBN-13: 9780321929150

**SEMESTER-IV****Course code and title:** USMRP-243 Practical based on USMR-241 and USMR-242**Lectures: 78 (Credits- 2)****Course Outcomes:**

1. Students will learn about mutagenesis, mutation and mutants and their significance.
2. Students will learn to determine portability of water with respect to fecal contamination.

Sr. No.	Topic	No. of Lectures
1	Staining Techniques: i. Flagella Staining ii. Metachromatic Granules	2
2	Air sampling using an air sampler, calculation of air flora from different locations with the knowledge of respective standards of bacterial and fungal counts.	1
3	Air Flora: a. Diversity determination. b. Simpson index and settling velocity determination	1
4	Bacteriological tests for potability of water a. MPN, Confirmed and Completed test. b. Membrane filter technique (Demonstration)	3
5	i. UV- survival curve ii. Induction of mutation by using physical mutagen (e.g. U V rays) iii. Isolation of auxotrophic mutants by Replica Plate Technique	2
6	Enrichment, Isolation, Preparation of Bioinoculants i. a) <i>Azotobacter</i> species and b) <i>Rhizobium</i> species Or ii. Blue Green Algae (Cyanobacteria)	2
7	Visit to Industry/ Drinking Water treatment plant	1

**Suggested references:****Experiment 1. Staining Techniques**

1. Robert Cruickshank, Duguid J.P., Marmilon B.P. and Swain R.H.A. (1975). Medical Microbiology, The Practice of Medical Microbiology. Churchill Livingstone, Edinburgh London And New York.

**Experiment 2. Air sampling using an air sampler:**

1. Chosewood L. C. and Wilson D. E. (2007). Biosafety in Microbiological and Biomedical Laboratories. DIANE Publishing Company. USA
2. Crawford R. L. and Garland J. L. (2007). Manual of Environmental Microbiology. United States: ASM Press.
3. Geis A. P. (2020). Cosmetic Microbiology: A Practical Approach. United States: CRC Press.
4. Nakatsu C. H., Yates M. V., Miller R. V. and Pillai S. D. (2020). Manual of Environmental Microbiology. United States: Wiley.
5. Pepper I. L., Bredecker J. W. and Gerba C. P. (2011). Environmental Microbiology: A Laboratory Manual. Netherlands: Elsevier Science.
6. WHO Guidelines for Indoor Air Quality: Dampness and Mould. (2009). Philippines: WHO.

**Experiment 3. Air Flora:**

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India
2. Cox C. C. and Wathes C. M. (2020). Bioaerosols Handbook. United States: CRC Press.
3. Saxena J., Baunthiyal M. and Ravi I. (2015). Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publishers, Jodhpur, Rajasthan, India.
4. Verma A. S., Das S., and Singh A. (2014). Laboratory Manual for Biotechnology. S Chand and Company Limited, New Delhi, India

**Experiment 4. Bacteriological tests for potability of water**

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India
2. Atlas R. M. (1986; Digitized 2007). Basic and Practical Microbiology. United Kingdom: Macmillan.
3. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
4. Noll L. M. L. and De Gelder L. S. P. (2013). Handbook of Water Analysis, Third Edition. United States: Taylor and Francis.

**Experiment 5. Induction of mutations:**

1. Bisen P. S. (2014). Laboratory Protocols in Applied Life Sciences. United Kingdom: CRC Press.
2. Gunasekaran P. (2007). Laboratory Manual In Microbiology. New Age International (P) Limited New Delhi, India.

**Experiment 6.****6. i. a) Azotobacterspecies:**

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India
2. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India

3. Gunasekaran P. (2007). Laboratory Manual In Microbiology. New Age International (P) Limited New Delhi, India

**6. i. b) *Rhizobium* species:**

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India

2. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India

3. Gunasekaran P. (2007). Laboratory Manual In Microbiology. New Age International (P) Limited New Delhi, India

**6. ii. Blue Green Algae (Cyanobacteria):**

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India

2. Bisen P. S. (2014). Laboratory Protocols in Applied Life Sciences. United Kingdom: CRC Press.

3. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India

4. Kumar V. (2012). Laboratory Manual of Microbiology. Scientific Publishers, Jodhpur, Rajasthan, India