

# **Savitribai Phule Pune University**

*(Formerly University of Pune)*

**Three Year B.Sc. Degree Program in Microbiology**

**(Faculty of Science & Technology)**

**S. Y. B. Sc. (Microbiology)**

**Choice Based Credit System Syllabus**

**2019 Pattern**

**Savitribai Phule Pune University, Pune-411007**  
**Syllabus 2020-21**  
**S. Y. B. Sc. Microbiology Semester III and Semester IV**  
**Titles of the Papers**

Semester	Paper Code	Paper	Paper title
III	MB 231	I	Medical Microbiology and Immunology
	MB 232	II	Bacterial Physiology and Fermentation Technology
	MB 233	III	Practical based on MB 231 and MB 232
IV	MB 241	I	Bacterial Genetics
	MB 242	II	Air, Water and Soil Microbiology
	MB 243	III	Practical based on MB 241 and MB 242

**Equivalence of Previous Syllabus: S. Y. B. Sc. Microbiology**

Semester	Old version (2013 Pattern) implemented from 2014-15		New Syllabus (2019 Pattern) implemented from 2020-21	
	Course Number	Course title	Course Number	Course title
III	MB: 212	Industrial and Soil Microbiology	MB 231	Medical Microbiology and Immunology
	MB: 211	Bacterial Systematics and Physiology	MB 232	Bacterial Physiology and Fermentation Technology
IV	MB: 221	Bacterial Genetics	MB 241	Bacterial Genetics
	MB: 222	Air and Water Microbiology	MB 242	Air, Water and Soil Microbiology
	MB: 223 Annual Practical	Practical Course based on MB:211, MB:212, MB:221, MB:222	MB 233	Practical based on Theory papers MB 231 and MB 232
			MB 243	Practical based on Theory papers MB 241 and MB 242

## Semester III

## DSEC-MB-231: Medical Microbiology and Immunology

[2 Credits; 36 Lectures]

[1 credit=15 hrs x 60 mins 900mins/50mins= 18 lectures]

**Course Outcomes:**

- Understanding the concept of epidemiology with respect to terms like Incubation period, Viability, Susceptibility, Pathogenicity, Virulence, Pathogenesis, Lab diagnosis, Epidemic, Sporadic, Endemic and Pandemic.
- Acquainted with human pathogens such as *Escherichia coli*, *Staphylococcus aureus* and Fungi like Yeast- *Candida* as well as Dermatophytes.
- Principles of Chemotherapy are introduced based on Selective toxicity, Bioavailability, MIC, MBC, LD<sub>50</sub>. Accustomed with the terms Antagonism and synergism in drug administration., Antibiotic sensitivity, Antibiotic misuse/antibiotic overuse and Concept of drug resistance (e.g., MRSA, ESBL)
- Comprehend the term immunity with its types
- Get knowledge of haematopoiesis, Antigens and antibodies, Immunohematology, Inheritance of ABH antigens, Medico legal applications of blood groups
- Acquainted with Active and Passive immunization

MB-231	Medial Microbiology and Immunology	[36]
Credit I	Medical Microbiology	(18)
1	<b>Definitions</b> Incubation period, Viability, Susceptibility, Pathogenicity, Virulence, Pathogenesis, Lab diagnosis, Epidemic, Sporadic, Endemic, Pandemic	2
2	<b>Study of following pathogens with respect to</b> Classification, Morphological, Cultural and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy: <b>Bacteria:</b> a) <i>Escherichia coli</i> b) <i>Staphylococcus aureus</i> <b>Fungi:</b> a) <i>Candida</i> b) <i>Dermatophytes</i>	10

<b>3</b>	<b>Introduction to Chemotherapy</b> i. Selective toxicity, Bioavailability, MIC, MBC, LD50 ii. Antagonism and synergism in drug administration iii. Antibiotic sensitivity iv. Antibiotic misuse/antibiotic overuse v. Concept of drug resistance (e.g. MRSA, ESBL)	<b>6</b>
<b>Credit II</b>	<b>Immunology</b>	<b>(18)</b>
<b>4</b>	<b>Immunity</b> Definition, Types (Innate and acquired, active and passive, humoral and cell mediated)	<b>2</b>
<b>5</b>	<b>Formation of blood cells (Hematopoiesis)</b> Myeloid and lymphoid lineages and differentiation process Lymphocyte types	<b>4</b>
<b>6</b>	<b>Antigens and antibodies: Definition and Concept</b>	<b>2</b>
<b>7</b>	<b>Immunoematology</b> i. ABO and Rh blood group systems ii. Bombay blood group iii. Biochemistry of blood group substances iv. Inheritance of ABH antigens v. Medico legal applications of blood groups	<b>7</b>
<b>8</b>	<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	<b>3</b>

**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. 9th 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. 17th 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. 3rd 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, Pareen 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. 6th 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. 4th edition. Ryan K. J. and Ray C. G. (Editors). McGraw-Hill Companies. DOI: 10.1036/0838585299
20. 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 normovolemic hemodilution. Asian journal of transfusion science. 9(1):74–77
21. Standards Unit. National Infection Service. PHE Bacteriology – Test Procedures.TP. 27(4): Issue date: 16.01.19. 1-14
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23. Gangal S. and Sontakke S. (2013). Textbook of Basic and Clinical Immunology. Universities Press Private limited. Available also at Orientblackswan, India. ISBN: 9788173718298
24. Talwar G. P. (1983). Handbook of Immunology. Vikas Publishing Pvt. Ltd. NewDelhi.
25. Paul W. E. (2003): Fundamental Immunology. 5th edition. Lippincott Williams and Wilkins Publishers. ISBN: 9780781735148
26. 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
27. Zajic J. E. and Supplisson B. (1972). Emulsification and degradation of “Bunker C” fuel oil by microorganisms. Biotechnol. Bioeng. 14: 331-343.

**MB-232: Bacterial Physiology and Fermentation Technology****[2 Credits; 36 Lectures]****[1 credit=15 hrs x 60 mins = 900mins/50mins= 18 lectures]****Course Outcomes:**

- Acquainted with the term Enzymes, its nomenclature and classification and models for catalysis
- Understand the effect of pH, temperature, substrate concentration, enzyme concentration, activators and inhibitors on enzymes
- Understanding the concept of Bacterial Physiology with reference to metabolism, catabolism, anabolism, respiration and fermentation
- Comprehend the different metabolic pathways with structures
- Acquainted with design of a fermenter, fermentation parameters, use of media for industrial fermentations
- Understand the sources of contamination during fermentations

<b>Credit I</b>	<b>Bacterial Physiology</b>	<b>(18)</b>
<b>1</b>	<b>Enzymes</b>	
	i. 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
	ii. Nomenclature and classification as per IUB (up to class level).	2
	iii. Models for catalysis– a) Lock and key b) Induced fit c) Transition state.	1
	iv. Effect of pH and temperature, substrate concentration and enzyme concentration, activators and inhibitors of enzyme	3
	<b>Bacterial Physiology</b>	
	i. Definitions of Metabolism, catabolism, anabolism, respiration and fermentation	1

2	ii. Metabolic pathways (with structures) <ul style="list-style-type: none"> <li>a) Embden-Meyerhof-Parnas pathway (Glycolysis)</li> <li>b) Hexose monophosphate pathway</li> <li>c) Entner-Doudoroff pathway</li> <li>d) Phosphoketolase pathway (Pentose and hexose)</li> <li>e) TCA cycle (with emphasis on amphibolism) and Glyoxylate bypass</li> <li>f) Gluconeogenesis and its significance</li> </ul>	2 2 1 1 2 1
<b>Credit II</b>	<b>Fermentation Technology</b>	<b>(18)</b>
3	<b>Concept of fermentation technology</b> <ul style="list-style-type: none"> <li>i. Microbial biomass- based fermentation (Biofertilizer, biopesticide and Probiotics)</li> <li>ii. Production of Primary metabolites (Organic acids, amino acids, vitamins and enzymes)</li> <li>iii. Production of Secondary metabolites (Antibiotics)</li> <li>iv. Production of recombinant products (insulin and growth hormones)</li> <li>v. Production of Fermented food products (Cheese, yoghurt)</li> <li>vi. Microbial biotransformation (Steroid transformation)</li> </ul>	4
4	<b>Strains of industrially important microorganisms:</b> <ul style="list-style-type: none"> <li>i. Desirable characteristics of industrial strain</li> <li>ii. Principles and methods of primary and secondary screening</li> <li>iii. Master, working and seed culture; development of inoculum</li> <li>iv. Preservation and maintenance of industrial strains.</li> </ul>	5
5	<b>Design of a Fermenter (typical CSTR Continuous stirred Tank Reactor):</b> Different parts and their working	2
6	<b>Monitoring of different fermentation parameters</b> (Temperature, pH, aeration, agitation, foam)	2
7	<b>Types of fermentations: Batch, continuous and dual</b>	2
8	<b>Media for industrial fermentations:</b> Constituents of media (Carbon source, nitrogen source, amino acids, vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers)	2
9	<b>Contamination: Sources, precautions and consequences</b>	1



**References:**

- a. BIOTOL Series. (1993). Biotechnology by open learning series. Defense Mechanisms. Butterworth and Heinemann Ltd., Oxford
- b. Casida L. E. J. R. (2016). Industrial Microbiology. New Age International Private Limited. ISBN- 9788122438024
- c. 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)
- d. Madigan M. T., Martinko J. M. and Brock T. D. (2006). Brock's Biology of Microorganisms. Pearson Prentice Hall, Upper Saddle River.
- e. Moat A. G. and Foster J. W. (1988). Microbial Physiology. 2<sup>nd</sup> Edition. John Wiley and Sons New York.
- f. Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry. 8<sup>th</sup> edition. Mac Millan Worth Pub. Co. New Delhi. ISBN:9781319228002
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- h. Pepler H. L. and Perlman D. (1979). Microbial Technology. Volume 1: Microbial Processes. Academic Press, New York. ISBN: 978-0-12-551501
- i. Pepler H. L. and Perlman D. (1979). Microbial Technology. Volume II: Fermentation Technology (2nd Edition). Academic Press. ISBN: 9781483268279
- j. Prescott L. M., Harley J. P. and Klein D. A. (2005). Microbiology. 6<sup>th</sup> Edition. Mac Graw Hill Companies Inc. (Unit II)
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- l. Stanbury P. F., Whitaker A. and Hall S. J. (2016). Principles of Fermentation Technology. 3<sup>rd</sup> Edition. Butterworth-Heinemann. ISBN: 9780080999531
- m. Voet D. and Voet J. G. (1995). Biochemistry. 2<sup>nd</sup> Edition. John Wiley & sons. New York. ISBN 0-471-58651-X

**MB-233: Practical Course based on**  
**MB-231: Diagnostic Microbiology and Immunology**  
**and**  
**MB-232: Bacterial Physiology and Fermentation Technology**  
**[2 Credits: 78 Lectures]**

**[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures]**

78 L distributed as 60 L for performing practicals and 18 L for internal evaluation

**12 Practical x 5 lectures = 60 Lectures**

<b>Semester III: Practical course based on MB 231 and MB 232</b>		
<b>Expt. No.</b>	<b>Topics</b>	<b>No. of Practical</b>
<b>1</b>	Measurements of cell dimension by micrometry using 10x, 45x and 100x objectives	<b>1</b>
<b>2</b>	Staining techniques: Cell Wall Staining	<b>1</b>
<b>3</b>	Blood grouping: ABO, Rh and Bombay blood group (anti H Lectin test)	<b>1</b>
<b>4</b>	Isolation and identification of pathogens from clinical samples: <i>(Escherichia coli, Staphylococcus aureus and Proteus)</i> by a. Gram staining & motility, b. Cultural and Biochemical characteristics i. Sugar utilization test, ii. Sugar fermentation test, iii. Triple Sugar iron agar, iv. IMViC test v. Enzyme detection – Gelatinase, Catalase, Oxidase, Coagulase (free and bound) vi. Oxidative-fermentative test [Baird Parker's modification of Hugh and Leifson's oxidative- fermentative (OF) basal medium for Gram Positive and Hugh and Leifson's oxidative- fermentative (OF) basal medium for Gram negative; Public Health England, 2019]	<b>6</b>

<b>5</b>	<b>Primary screening of industrially important organisms:</b>	<b>2</b>
	a. Screening and isolation of antibiotic <b>and</b> organic acid producing organism from soil by Crowded plate and <b>Giant colony method</b>	
	b. Microorganisms producing industrially important enzyme-amylase	<b>1</b>
	<b>Total</b>	<b>12</b>

**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
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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, Indi

**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
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 *Mycoplana* 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*.United Kingdom: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. Second Edition. 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.

## S. Y. B. Sc. Microbiology Syllabus (Semester IV)

## MB-241: Bacterial Genetics

[2 Credits; 36 Lectures]

[1 credit=15 hrs x 60 mins = 900mins/50mins= 18 lectures]

## Course Outcomes:

- Understanding the different experimental evidence for nucleic acid as genetic material
- Comprehend the different types of nucleic acids, Structure of DNA and Prokaryotic DNA replication.
- Understand the different models and modes of DNA replication with its basic rules of DNA replication
- Get knowledge of Gene expressions, Mutations and reversions
- Acquainted with Plasmid genetics

MB 241	Bacterial Genetics	[36]
Credit I	Topics	(18)
1	<b>Understanding DNA:</b>	7
	<b>i. Experimental evidence for nucleic acid as genetic material.</b>	
	a. Discovery of transforming material (hereditary material): b. Griffith's experiment c. Avery and MacLeod experiment d. Gierer and Schramm e. Fraenkel-Conrat and Singer experiment (TMV virus) f. Hershey and Chase experiment	
	<b>ii. Types of nucleic acids (DNA and RNAs)</b>	1
	<b>iii. Structure of DNA</b>	2
	a. Structure of Nitrogen bases, Nucleoside, Nucleotide and polynucleotide chain b. Bonds involved in DNA structure c. Different forms of DNA	
2	<b>iv. Prokaryotic DNA replication</b>	8
	a. Models of DNA replication (Conservative, semi-conservative and Dispersive) b. Meselson and Stahl's experiment (semi-conservative) c. Six basic rules of DNA replication d. Enzymes, proteins and other factors involved in DNA replication. e. Modes of DNA replication Rolling circle mechanism, theta and linear DNA replication	

Credit II	Topics	(18)
3	<b>i. Gene expression</b> a. Concept of Genetic code and its properties b. Concept of transcription and translation	2
4	<b>ii. Mutations and reversions</b> Concept of Mutation and Types of mutations: Nonsense, Missense, Silent, Conditional lethal-temperature sensitive, Amber, Reverse, suppressor  a. Spontaneous Mutation <ul style="list-style-type: none"> <li>• Discovery of spontaneous mutation (Fluctuation test)</li> <li>• Mechanism of spontaneous mutation</li> <li>• Isolation of Mutants: Replica plate technique</li> </ul> b. Concept of Induced Mutations <ul style="list-style-type: none"> <li>• Base pair substitution (Transitions, Transversions), Insertions and deletions-Frame / Phase shift mutations</li> <li>• Physical Mutagenic agent: UV and X-ray</li> <li>• Chemical mutagenic agents</li> <li>• Base analogues (2 amino purine, 5 bromouracil),</li> <li>• HNO<sub>2</sub>, Alkylating agents</li> <li>• Intercalating agents (EtBr, acridine orange)</li> </ul>	10
5	<b>iii. Plasmid genetics</b> a. Types of plasmids b. Properties of Plasmid c. Plasmid replication d. Plasmid incompatibility e. Plasmid curing f. Plasmid amplification Concept	6

**References:**

1. Brooker R. J. (2012). Genetics: Analysis and Principles. 4<sup>th</sup> edition. McGraw- Hill- Publication
2. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P. (2008). Molecular Biology of the Cell. 5<sup>th</sup> 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. 8<sup>th</sup> 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). 10<sup>th</sup> 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 Dagainawala. General Microbiology. Vol. I and vol II. 1<sup>st</sup> Edition. Himalaya Publishing House, Mumbai
10. Primrose S. B. (2002) .Principles of Gene Manipulation. 6<sup>th</sup> 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. 3rd Edition. New Delhi: PHI Learning Gardner



## S. Y. B. Sc. Microbiology Syllabus (Semester IV)

## MB-242: Air, Water and Soil Microbiology

[2 Credits; 36 Lectures]

[1 credit=15 hrs x 60 mins = 900mins/50mins= 18 lectures]

**Course Outcomes:**

- The course will help them to get knowledge of the Air Microbiology, methods of air sampling, different types of air samplers, air sanitation and airborne infections.
- Deals with water microbiology including bacteriological analysis of water, methods of water purification, water borne infections and bacteriological standards of water quality.
- Understand Soil Microbiology, rhizosphere, composting and humus formation, biofertilizers, biocontrol agents and microbial interactions.
- Acquire knowledge of carbon and nitrogen cycles with role of microorganisms.

MB-242	Air, Water and Soil Microbiology	[36]
Credit I	Air Microbiology and Water Microbiology	18
1	<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. Airborne infections	1
	<b>ii. Water Microbiology</b>	
	a. Types of water: surface, ground, stored, distilled, mineral and de-mineralized water	1

2	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
	e. Indicators of faecal pollution: <i>Escherichia coli</i> , <i>Bifidobacterium</i> , <i>Streptococcus faecalis</i> , <i>Clostridium perfringens</i> , New indicators: <i>Campylobacter</i> and <i>Pseudomonas</i>	2
	f. <b>Bacteriological analysis of water for potability</b> <ol style="list-style-type: none"> <li>i. Bacteriological standards of potable water: Bureau of Indian standards (BIS)</li> <li>ii. World Health Organization (WHO)</li> <li>iii. Presumptive coliform count</li> <li>iv. Confirmed test</li> <li>v. Completed test</li> <li>vi. Eijkman test</li> <li>vii. Membrane filter technique</li> </ol>	4
<b>Credit II</b>	<b>Soil Microbiology</b>	<b>18</b>
	a. Rhizosphere microflora and its role in the rhizosphere	1
	b. Role of microorganisms in composting and humus formation	2
	c. Biofertilizers: Bacterial, Cyanobacterial, fungal and their large-scale production	3
	d. Biocontrol agents: Bacterial, Viral, Fungal and their large-scale production	3
	e. Brief account of microbial interactions: Symbiosis, Neutralism, Commensalism, Competition, Ammensalism, Synergism, Parasitism and Predation	5

	f. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen	4
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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
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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 Dagainawala 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
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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. 8thEdition. Cambridge University Press
17. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
18. Subba Rao N. S. (1977). Soil Microbiology. 4thEdition. 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

## S.Y. B. Sc. Microbiology Syllabus (Semester IV)

## MB-243: Practical Course based on

## MB-241: Bacterial Genetics and MB-242: Air, Water and Soil Microbiology

[2 Credits: 78 Lectures]

[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures]

78 L distributed as 60 L for performing practicals and 18 L for internal evaluation

12 Practical x 5 lectures = 60 Lectures

Semester IV: MB-243: Practical course based on MB 241 and MB 242		
Expt. No.	Topics	No. of Practical
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 and Application 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
	<b>Total</b>	<b>12</b>

**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.
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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. Nollert 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) *Azotobacter* 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. 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