

Progressive Education Society's
**Modern College of Arts, Science and Commerce (Autonomous),
Shivajinagar, Pune 5**

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Syllabus For

Second Year B. Sc. (Microbiology)

Choice Based Credit System (CBCS) Syllabus Under
National Education Policy (NEP)
To be implemented from Academic Year 2024-

Level:- 5.0 (Second Year) Sem:III FRAMEWORK

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24ScMicU3101	Environmental Microbiology I & Metabolism	4		4		40	60	100
	24ScMicU3102	Lab Course on 24ScMicU3101		2		4	20	30	50
VSC P(2)	24ScMicU3501	Lab Course on Dairy Microbiology		2		4	20	30	50
IKS (T/P)(2)	24ScMicU3901	Vedic Microbiology	2		2		20	30	50
FP P(2)	24ScMicU3002	Field Project I		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24ScMicU3301	Soil and Agricultural Microbiology	2		2		20	30	50
	24ScMicU3302	Lab Course on 24ScMicU3301		2		4	20	30	50
GE/OE (T/P) (2)	24ScMicU3401	Introduction to Microbial World 2	2		2		20	30	50
AEC T(2)	24CpCopU3703	English Communication Skills II	2		2		20	30	50
CC T(2)	24CpCopU3001	Online Course on Yoga	2		2		20	30	50
Total			14	08	14	16			550

**Progressive Education Society's
Modern College of Arts, Science, and Commerce
Shivajinagar, Pune-5
Second Year of B.Sc.
(2023 Course under NEP2020)
Course Code: 24ScMicU3101**

Course Name: Environmental Microbiology I & Metabolism

Teaching Scheme (TH): 4 Hours/Week

Credit: 04

Examination Scheme: CIA: 40 Marks

End Sem : 60 Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course Objectives:

Section I:

- To introduce soil microflora.
- To enrich students with knowledge of how to use microorganisms in soil in agriculture.
- To develop an interest in the agricultural field.

Section II:

- To learn and understand main metabolic pathways in prokaryotes.
- To provide a deeper insight into the fundamentals of enzyme structure and role in metabolism.
- To review and consolidate integrity between metabolism and the energy economy of a cell.

Course Outcomes:

Section I:

On completion of the course, student will–

- Become well versed with the microbial flora of soil and the interaction of those microorganisms with one another.
- Learn about the use of microorganisms as an application to control plant disease and enhance yield.
- Understand about eco-friendly agricultural techniques.

Section II:

On completion of the course, student will be able to–

- Discuss factors that affect enzymatic activity.
- Understand significance of metabolic pathways in energy generation.
- Apply bioenergetics principles in understanding metabolism.

Major Core theory

Course Contents:

Section I: Environmental Microbiology I		
Unit I	Introduction to Soil Microbiology	No. of Lectures
	A. Introduction to Soil ● Concept of Soil formation, Composition of soil, different types of soil (sand, loamy, clay, silt) ● Soil microorganisms – Bacteria, algae, fungi, actinomycetes, protozoa and their proportion in the soil depending upon various conditions like environmental and competition.	15

	B. Introduction to Rhizosphere ● Rhizosphere microflora and its role in rhizosphere C. Role of microorganisms in following elemental cycles in nature ● Carbon, Nitrogen, Sulphur, Phosphorus cycles D. Degradation of organic matter ● Source of organic matter, degradation of plant and animal matter, description of humus and humus formation steps ● Degradation of cellulose, hemicelluloses, lignin and pectin	
Unit II	Application of soil microflora in agriculture	No. of Lectures
	A. Plant growth promoting rhizobacteria (PGPR), biofertilizers ● Nitrogen Fixation ● Phosphate solubilization ● Potassium mobilization ● Iron chelation ● Indole acetic acid production ● Siderophore production B. Biocontrol agents: Bacterial, Viral and Fungal.	15
Section II: Metabolism		
Unit I	Biocatalysts	No. of Lectures
	A. Introduction to Enzymes Nature of active site, ribozymes, coenzymes, apoenzymes, prosthetic group and cofactors. Nomenclature & classification as per IUB (upto class level). Structure of active site; common amino acids at active site B. Models for catalysis ● Lock and key ● Induced fit ● Transition state. C. Specific catalytic groups involved in enzyme catalyzed reactions (Acid-base catalysis, metal ion catalysis, covalent catalysis). D. Effect of pH & temperature, substrate concentration & enzyme concentration, activators and inhibitors of enzyme	15
Unit II	Basic concepts of metabolism	No. of Lectures
	A. Definitions of Metabolism, catabolism, anabolism, respiration and fermentation B. Metabolic pathways (with structures and regulation) EMP, HMP, ED. TCA (emphasis on amphibolism), Glyoxylate, Homofermentative and heterofermentative pathways, Interconnectivity of pathways. C. Bioenergetics High Energy Compounds Electron transport chain, Oxidative phosphorylation and Substrate level phosphorylation, Chemiosmotic hypothesis of ATP formation, Concept of Standard redox potential (Nernst equation)	15

References**Section I :**

1. Subba Rao N. S. (1977) Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co.Pvt. Ltd.
2. Martin A. (1977) An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
3. Alexander M. (1977) Introduction to soil microbiology, John Wiley NY
4. Dube H.C. and Bilgrami. K.S.(1976) Text book of modern pathology. Vikas Publishing house. New Delhi
5. Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi
6. John Postgate, (1998). Nitrogen Fixation. Cambridge University Press
7. Ajay Singh, Owen P. Ward, 2004 edition, Applied Bioremediation and Phytoremediation (Soil Biology). Springer
8. Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
9. Madigan M.T, Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
10. Tortora G.J., Funke B.R., Case C.L. (2006) Microbiology: An Introduction. 8th Edition.
11. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub.Co. NY
12. Pelczar M. J., Chan E. C. S., Krieg N. R.(1986) Microbiology. 5th Edition, McGraw-Hill Publication
13. Prescott, Lancing M., John, P. Harley and Donald, A. Klein(2006) Microbiology, 6th Edition, McGraw Hill Higher Education
14. Hans G. Schlegel (1993) General Microbiology, 8th Edition, Cambridge University Press
15. Martin Frobisher (1937) Fundamentals of Microbiology, 8th Edition, Saunders, Michigan University press
16. Moshraffuddin Ahmed, SK Basumatary (2006) Applied Microbiology, MJP Publishers.

Section II :

1. Conn E., Stumpf P.K., Bruening G., Doi R.H. (1987) Outlines of Biochemistry 5th Edition, John Wiley and Sons, New Delhi.
2. Nelson D. L. & Cox M. M. (2013) Lehninger's Principles of Biochemistry, 6th edition, W. H. Freeman & Co. NY
3. Voet D. & Voet J. G. (2015) Biochemistry, 4th edition. John Wiley & sons New York.
4. Bergey D. H. & Holt J. G. (1994) Bergey's Manual of Determinative Bacteriology. 9th Edition. Lippincott Williams & Wilkins.
5. Garrity G. M. (2005) Bergey's Manual of Systematic Bacteriology. 2nd Edition. (Vols. 1 – 4). Williams & Wilkins.
6. Madigan M. T., Martinko J. M. (2017) Brock's Biology of Microorganisms. 15th Edition. Pearson Education Inc.
7. Prescott L. M., Harley J. P. and Klein D. A. (2011) Microbiology, 8th Edition. McGraw Hill Companies Inc.

Progressive Education Society's**Modern College of Arts, Science and Commerce(Autonomous),****Shivajinagar, Pune - 5****SecondYear of B.Sc. Microbiology (2020 Course)****Course Code: 23ScMicU3102****Course Name :Lab course based on 23ScMicU3101****Teaching Scheme: TH: 4 Hours/Week****Credit: 2****Examination Scheme: CIA : 20 Marks****End-Sem : 30 Marks****Prerequisite Courses: First Year B.Sc. Microbiology****Course Objectives:**

- To enrich students with the knowledge of biochemical characterization of bacteria.
- To introduce the concept of bacterial growth kinetics.
- To promote significance of plant growth promoting rhizobacteria in sustainable agriculture by enhancing knowledge of their benefits, mechanisms and applications.

Course Outcomes:

On completion of the course, student will be able to :

- Understand biochemical approaches in Identification of microorganisms and learn to partially characterize the bacteria.
- Develop insight about bacterial growth kinetics.
- Design the experiments to screen for potential plant growth promoting rhizobacteria, which can be efficiently applied in production of biofertilizers.

Major Core practical**Course Contents:**

Sr. No	Name of the practical	No. of practical's
1	Biochemical characterization of bacteria: a. Sugar utilization test (minimal medium+ sugar) b. Sugar fermentation test c. Enzyme detection – Amylase, Gelatinase, Catalase, Oxidase d. Oxidative-fermentative test e. IMViC Test	8
2	Growth curve: a. Absorbance measurement for bacterial culture b. Calculation of growth rate, specific growth rate and generation time c. Graph plotting by using computer software.	3
3	Enrichment, Isolation of plant growth promoting bacteria a. Nitrogen fixing bacteria b. Phosphate solubilizing bacteria c. Development of biofertilizer	4

References:

1. Salle A.J. (2007). Fundamental Principles of Bacteriology. 7th Edition, Dodo Press.

2. Martin A. (1991). Introduction to Soil Microbiology 2nd Edition, John Wiley&Sons, New York and London publication.
3. Subba Rao N. S. (2017.) Soil Microbiology, 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd..
4. Sikyta, B. (1995). Techniques in applied microbiology (Vol. 31). Elsevier.
5. Sadasivam S. and Manickam A.(2004), "Biochemical Methods," 3rd Edition, New Age International (P) Limited Publishers, New Delhi
6. Plummer D.T.(2006). Introduction to practical biochemistry. 3rd Edition Tata McGraw Hill Education

Progressive Education Society's**Modern College of Arts, Science and Commerce (Autonomous),****Shivajinagar, Pune - 5****Second Year of B.Sc. Microbiology (2020 Course)****Course Code: 24ScMicU3501****Course Name: Lab Course on Dairy Microbiology****Teaching Scheme: TH: 4 Hours/Week****Credit: 2****Examination Scheme: CIA : 20 Marks****End-Sem : 30 Marks****Prerequisite Courses: First Year B.Sc. Microbiology****Course objective:**

- To develop practical skills through hands-on laboratory exercises, including microbial enumeration, isolation, identification, and interpretation of results, to reinforce theoretical concepts and enhance proficiency in milk microbiological analysis
- To know about pathogenic, non-pathogenic and useful microorganisms dairy industry.
- To become aware about the testing methods routinely used for testing milk quality.

Course outcomes:

On completion of the course, student will be able to–

- Students will be able to describe the role of microorganisms in spoilage of milk.
- Students will develop experimental skills for testing the milk for the presence of microorganisms

SEC T (2)**Course Contents:**

Sr. No	Name of the practical	No. of practical's
1	Tests for Milk and Dairy products - Phosphatase test - MBRT test and Resazurin test - Test for mastitis - Milk adulteration test- Urea, starch, detergent - Direct microscopic count - Somatic cell count Milk fat estimation (demonstration)	9
2	- Standard Plate Count (compare pasteurized and unpasteurized milk) - Isolation of bacteria from pasteurized milk and unpasteurized milk and identification of any one isolate upto genus level.	6

References

1. Banwart G. J. (1989). Basic Food Microbiology, 2nd Edn. Chapman and Hall, International Thompson Publishing.
2. Deeth, H.C., & Fitz-Gerald, C.H. (1994). Methylene blue reduction test for the estimation of bacterial numbers in milk. Australian Journal of Dairy Technology
3. Clarence Henry Eckles, Willes Barnes Combs, Harold Macy (1943). Milk and milk products, 4th Ed. McGraw-Hill Book Company, Incorporated.
4. James M. Jay, Martin J. Loessner, David A. Golden (2005). Modern Food Microbiology, 7th

Edn. Springer Science & Business.

5. Sukumar De (2001). Outlines of Dairy Technology. 1st Ed. Oxford University Press, Delhi.
6. Marth, E.H., & Steele, J.L. (Eds.). (2001). Applied Dairy Microbiology ,2nd ed.. Marcel Dekker.

Progressive Education Society's**Modern College of Arts, Science and Commerce(Autonomous),****Shivajinagar, Pune - 5****Second Year of B.Sc. Microbiology (2020 Course)****Course Code: 24ScMicU3901****Course Name : Vedic Microbiology (Scientific Perspective)****Teaching Scheme: TH: 4 Hours/Week****Credit: 2****Examination Scheme: CIA : 20 Marks****End-Sem : 30 Marks****Prerequisite Courses: First Year B.Sc. Microbiology****Course Objective :**

- To introduce students with history of microbiology in India
- To aware students regarding the importance of Indian knowledge in the discovery of Microbiology.
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Course Outcomes :

After completion of this course students will able to-

- Explain importance of Indian knowledge in Microbiology Describe Vedic knowledge importance in history of Microbiology.
- Compare Vedic knowledge and current science development Illustrate the difference between Vedic and Modern science.4
- Justify role of Vedic science in development of current science Criticize on basis of Vedic and current science

IKS (T/P)(2)**Course Contents:**

Unit I	Introduction to vedic science	No. of Lectures
	● Introduction to Vedas ● Vedic period and Aryans ● Origin of Universe ● Prevalence of Microorganisms : Germ theory of diseases first established by Vedic Rishis and was recorded in Vedas ● Microbes and fermentation like curd, liquor, fermented food	12
Unit II	Prevention and elimination of microorganisms	No. of Lectures
	● Classification of microorganisms, ● Human health and disease caused by worms ● Origin and prevalence of worms ● Elimination of worms by sun rays ● Elimination of worms by medicinal plants ● Science of Agnihotra ● Agastya Rishis' discovery in Use of Biological weapons of ● Mass Destruction	18

References:

1. Suraj Sharma and Aniota Sharma (2017) Science and Arts of Happy Living (Traditional and Modern), PiRamal Publications, Delhi
2. Ramesh Dubey (2020) Vedic Microbiology (Scientific Approach), Ashtha Prakashan, Delhi, India
3. Dr. Chakradhar Friend, Dr. Shirij Kurup, Vedic Microbiology, Indian Foundation for Vedic Science, India
4. Fathima Hilmiyya T.M, Biological Warfare A Weapons Of Mass Destruction, Journal of Emerging Technologies and Innovative Research, Vol 6 Issue-4

Progressive Education Society's**Modern College of Arts, Science and Commerce(Autonomous),****Shivajinagar, Pune - 5****Second Year of B.Sc. Microbiology (2020 Course)****Course Code: 24ScMicU3301****Course Name : Soil and Agricultural Microbiology****Teaching Scheme: TH: 4 Hours/Week****Credit: 2****Examination Scheme: CIA : 20 Marks****End-Sem : 30 Marks****Prerequisite Courses: First Year B.Sc. Microbiology****Course Objectives:**

- To introduce soil microflora.
- To enrich students with knowledge of how to use microorganisms in soil in agriculture.
- To develop an interest in the agricultural field.

Course Outcomes:

On completion of the course, student will–

- Become well versed with the microbial flora of soil and the interaction of those organisms with one another.
- Learn about the use of microorganisms as an application to control plant disease and enhance yield.
- Understand about eco-friendly agricultural techniques

Minor theory**Course Contents:**

Unit I	Introduction to Soil Microbiology	No. of Lectures
	A. Introduction to Soil ● Concept of Soil formation, Composition of soil, different types of soil (sand, loamy, clay, silt) ● Soil microorganisms – Bacteria, algae, fungi, actinomycetes, protozoa and their proportion in the soil depending upon various conditions like environmental and competition. B. Introduction to Rhizosphere ● Rhizosphere microflora and its role in rhizosphere C. Role of microorganisms in following elemental cycles in nature ● Carbon, Nitrogen, Sulphur, Phosphorus cycles D. Degradation of organic matter ● Source of organic matter, degradation of plant and animal matter, description of humus and humus formation steps ● Degradation of cellulose, hemicelluloses, lignin and pectin	15
Unit II	Application of soil microflora in agriculture	No. of Lectures

	A. Plant growth promoting rhizobacteria (PGPR), biofertilizers ● Nitrogen Fixation ● Phosphate solubilization ● Potassium mobilization ● Iron chelation ● Indole acetic acid production ● Siderophore production B. Biocontrol agents: Bacterial, Viral, Fungal and their large scale production	15
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References:

1. Subba Rao N. S. (1977) Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd.
2. Martin A. (1977) An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
3. Alexander M. (1977) Introduction to soil microbiology, John Wiley NY
4. Dube H.C. and Bilgrami. K.S. (1976) Text book of modern pathology. Vikas publishing house. New Delhi
5. Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi
6. Ajay Singh, Owen P. Ward, 2004 edition, Applied Bioremediation and Phytoremediation (Soil Biology). Springer
7. Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole
8. Madigan M.T, Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
9. Tortora G.J., Funke B.R., Case C.L. (2006) Microbiology: An Introduction. 8th Edition.
10. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY
11. Pelczar M. J., Chan E. C. S., Krieg N. R. (1986) Microbiology. 5th Edition, McGraw-Hill Publication
12. Prescott, Lancing M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education

Progressive Education Society's

**Modern College of Arts, Science and Commerce(Autonomous),
Shivajinagar, Pune - 5**

**Second Year of B.Sc. Microbiology (2020
Course)**

Course Code: 24ScMicU3302

Course Name : Lab Course on 24ScMicU3301

Teaching Scheme: TH: 4 Hours/Week

Credit: 2

Examination Scheme: CIA : 20 Marks

End-Sem : 30 Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course Objectives:

- To promote significance of plant growth promoting rhizobacteria in sustainable agriculture by enhancing knowledge of their benefits, mechanisms, and applications.
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Course Outcomes:

On completion of the course, student will be able to :

- Design the experiment to screen for potential plant growth promoting rhizobacteria, which can be efficiently applied in production of biofertilizers.

Minor practical**Course Contents:**

Sr. No	Name of the practical	No. of practical's
1	Enumeration of microorganisms from soil sample using spread plate and pour plate technique	6
2	Enrichment, Isolation of plant growth promoting bacteria a. Nitrogen fixing bacteria b. Phosphate solubilizing bacteria c. Development of biofertilizer	6
3	Preservation of Bacterial cultures and revival of cultures	3

References

- 1.Subba Rao N. S. (1977) Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd.
- 2.Martin A. (1977) An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
- 3.Mexander M. (1977) Introduction to soil microbiology, John Wilery NY
- 4.Dube H.C. and Bilgrami. K.S.(1976) Text book of modern pathology. Vikas publishing house. New Delhi
- 5.Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi
- 6.Ajay Singh, Owen P. Ward, 2004 edition, Applied Bioremediation and Phytoremediation (Soil Biology). Springer
- 7.Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole
- 8.Madigan M.T, Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson

Education Inc.

9.Tortora G.J., Funke B.R., Case C.L. (2006) Microbiology: An Introduction. 8th Edition.

10.Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY

11.Pelczar M. J., Chan E. C. S., Krieg N. R.(1986) Microbiology. 5th Edition, McGraw-Hill Publication

12.Prescott, Lancing M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education

Progressive Education Society's
Modern College of Arts, Science and Commerce,
Shivajinagar, Pune - 5
Second Year of B.Sc
(2024 Course under NEP 2020)
Course Code :23ScMicU3401
Course Name : Introduction to microbial world-II

Teaching Scheme: TH. 2 Hours/Week

Credit 02

Examination Scheme: CIA : 20 Marks

End-Sem : 30 Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course objectives

- To identify and differentiate between various types of acellular microorganisms such as viruses, viroids, and prions
- To understand the morphological features of different groups of acellular microorganisms
- To learn media preparation and cultivation of microorganisms

Course outcomes

On completion of the course, student will be able to–

- Differentiate between various types of acellular microorganisms such viruses, viroids, and prions
- Describe the characteristics of various acellular microorganisms
- Understand the criterion used for classification of microorganisms
- Learn preparation of culture media, cultivation of various types of microorganisms and maintenance microbial cultures.

OE

Course Contents:

Unit I	Diversity of Microorganisms	No. of lectures
	A. Types of microorganisms and their characteristics General characteristics including details of the morphology of different groups with emphasis on morphology and mode of reproduction: Acellular microorganisms (Viruses, Viroids, and Prions) B. Classification of microorganisms: ● Introduction to Bergey's manual of classification ● Introduction to different groups of viruses	15
Unit II	Cultivation of microorganisms	No. of lectures
	● Nutritional requirements and their classification	15

	● Design and preparation of media: Common ingredients of media and functional types of media ● Methods for cultivating bacteria, algae, fungi, and protozoa ● Concept of enrichment, pure culture and isolation ● Maintenance of bacterial and fungal cultures by using various techniques	
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1. References:

2. Salle, A. J. (1971) Fundamental Principles of Bacteriology 7th edition, Tata Mc Graw Hill Publishing Co, USA.
3. Ingraham, J. L., & Ingraham, C.A. (2013). Introduction to Microbiology. Wadsworth Publishing, Company, USA.
4. Madigan, M.T., & Martinko, J. M. (2019). Microorganisms and microbiology.
5. Brock biology of Microorganism, 15th edition, Pearson Education New York (NY). .
6. Tortora, G. J. , Funke, B. R., Case, C. L. , & Johnson, T. R. (2016). Microbiology : an introduction. 12th edition, Pearson Education
7. Michael, J. P. (2009). Microbiology : An Application-Based Approach. Tata McGraw Hill Education Private Limited.
8. Willey, J. M., Sherwood, L., & Woolverton, C. J. (2013).
9. Prescott, Harley, and Klein's microbiology. 8 th edition, McGraw-Hill Higher Education.
10. Salle, A. J. (1971). Fundamental Principles of Bacteriology. 7 th edition. Tata McGraw Hill Publishing Co.
11. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1987). General Microbiology., 5th edition. Macmillan Press Ltd.
12. Brown, J. H. (1939). Bergey's manual of determinative bacteriology.

Semester IV SY

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24ScMicU4101	Environmental Microbiology II and Bacterial Genetics	4		4		40	60	100
	24ScMicU4102	Lab Course on 24ScMicU4101		2		4	20	30	50
VSC P(2)	24ScMicU4501	Lab Course on Food Microbiology		2		4	20	30	50
CEP P(2)	24ScCopU4003	Community Engagement Project		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24ScMicU4301	Air and Water Microbiology	2		2		20	30	50
	24ScMicU4302	Lab Course on 24ScMicU4301		2		4	20	30	50
GE/OE (T/P) (2)	24ScMicU4401	Community Hygiene	2		2		20	30	50
SEC T(2)	24ScMicU4601	Basics of fermentation technology	2		2		20	30	50
AEC T(2)	24CpCopU4701 / 24CpCopU4702	MIL-II (Hindi) / MIL-II (Marathi)	2		2		20	30	50
CC T(2)	24CpCopU4001	Health and Wellness	2		2		20	30	50
Total			14	8	14	16			550

Progressive Education Society's
Modern College of Arts, Science and Commerce(Autonomous),
Shivajinagar, Pune - 5
Second Year of B.Sc. Microbiology (2020 Course)
Course Code: 24ScMicU4101
Course Name: Environmental Microbiology II and Bacterial Genetics
Teaching Scheme: TH: 4 Hours/Week **Credit: 4**
Examination Scheme: CIA : 20 Marks **End-Sem : 30 Marks**
Prerequisite Courses: First Year B.Sc. Microbiology

Course Objectives:**Section I**

- Understand the varied air and water microflora.
- Understand the methods to determine the microorganisms present in air and water.
- To get versed with the techniques to treat and prevent air and water pollution.

Section II

- Discuss the most significant discoveries and theories through the historical progress of biological scientific discoveries in the development of molecular biology.
- Explain the fundamental structure, properties of nucleic acids.

Course Outcomes:**Section I**

On completion of the course, student will be able to–

- Identify the microbes in air and water and the diseases associated with it.
- Get versed with the diversity of microbes present around us and will be able to determine them.
- Learn new ways to determine microbes from a raw sample.

Section II

On completion of the course, student will be able to–

- Revisit and review the RNA world theory and outline the key events in evolution of life on earth.
- Illustrate, differentiate and contrast between the structures of DNA and also discuss the DNA replication process.
- Study the experiments that led to the discovery of DNA, RNA as genetic material and apply the concepts in understanding the basics of genetics.
- Discuss and compare spontaneous or induced mutation theories.
- Understand significance of fluctuation test.
- Describe types of mutations and mutagenic agents and their action on functioning of a cell.

Major Core Theory**Course Contents:**

Section I: Environmental Microbiology II		
Unit I	Air Microbiology	No. of Lectures
	A. Air flora • Transient nature of air flora • Droplet, droplet nuclei, and aerosols B. Methods of Air sampling and types of air samplers	15

	● Impaction on solids ● Impingement in liquid ● Sedimentation ● Centrifugation ● Precipitation ● Thermal Precipitation C. Air sanitation ● Physical and chemical methods ● Air borne infections	
Unit II	Water Microbiology	No. of Lectures
	A. Types of water ● Surface, ground, stored, distilled, mineral and de-mineralized water ● Bacteriological standards of potable water ● Maharashtra pollution control board (MPCB), Central pollution control board(CPCB), Bureau of Indian standards (BIS),World health Organization (WHO) B. Water purification methods of drinking water C. Indicators of faecal pollution; ● <i>Escherichia coli</i>, <i>Bifidobacterium</i>, ● <i>Introduction to Streptococcus faecalis</i>,<i>Clostridium perfringens</i>; ● New indicators: <i>Campylobacter</i> and <i>Pseudomonas</i> D. Bacteriological analysis of water for potability ● Presumptive coliform count ● Confirmed test ● Completed test ● Eijkman test ● Hydrogen sulphide paper strip test ● Membrane filter technique E. Domestic WasteWater ● Analysis of wastewater - i.Physicochemical parameters: pH, temperature, total solids, suspended solids, Chemical Oxygen Demand - ii.Biological parameters: Introduction to Biological Oxygen Demand ,Toxicity (Fish bioassay) F. Industrial water pollutants, their ecological effects and health hazards ● Biomagnification and eutrophication G. Methods of effluent treatment ● Primary, secondary, tertiary treatment methods	15
Section II : Bacterial Genetics		
Unit I	Understanding molecules of heredity	No. of Lectures

	• RNA world and shift to DNA world with time • Discovery of transforming material (hereditary material): Griffith's experiment • Evidence for nucleic acid as genetic material -Avery and MacLeod experiment -Gierer and Schramm / Fraenkel-Conrat & Singer experiment (TMV virus)-Hershey & Chase experiment • Prokaryotic genome organization • Concept of Gene, basic structure of B form of DNA • Properties of nucleotides related with DNA stability • Comparative account of different forms of DNA B. DNA REPLICATION • Messelson and Stahl's experiment (semiconservative) • Mechanisms of DNA replication: Theta model (semi-discontinuous), J Cairn's experiment, rolling circle model (plasmid DNA, λ phage DNA)	18
Unit II	Mutations and Reversions	No. of Lectures
	A. Spontaneous mutations i. Occurrence and Mechanisms ii. Fluctuation test B. Mechanisms of induced mutations i. Base pair substitution (Transitions, Transversions), Base analogues (2 aminopurine, 5 bromouracil), HNO₂, Alkylating agents (ethyl methyl sulphonate) ii. Frameshift mutations (Insertions and deletions), Intercalating agents (EtBr, acridine orange), Cross linking agents (Psorolin, mitomycin), UV rays, X rays, Biological mutagens (bacteriophage μ, transposomes) C. Types of mutations: Nonsense, Missense, Silent, Null, Conditional lethal temperature sensitive, amber, leaky & non leaky D. Isolation of Mutants: Replica plate technique 1 E. Reversion: i. True reversion ii. Suppression (intragenic and intergenic).	12

References :

Section I :

1. Daniel Lim., Microbiology, 2nd Edition; McGraw-Hill Publication
2. Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3rd Edition.
3. Thomson Brooks / Cole. Madigan M.T, Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
4. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Publishing Co.

5. Tortora G.J., Funke B.R., Case C.L. (2006) Microbiology: An Introduction. 8th Edition.
6. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY
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11. Standard Methods for the Examination of Water and Wastewater (2005) 23rd Edition, Publication of the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton, Mary Ann H. Franson.

References Section II

1. Benjamin Lewin (2017) Genes XII. Oxford University Press
2. Friefelder D. (1995) Molecular Biology, 2nd Edition. Narosa Publishing House.
3. Gardner E.J., Simmons M.J and Snustad D.P. (1991) Principles of Genetics. 8th Edition. John Wiley & Sons Inc.
4. Russel Peter. Essential Genetics. 2nd Edition, Blackwell Science Pub.
5. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edition Macmillan Pub. Co. NY.
6. Stricberger M.W. (1985) Genetics. 3rd Edition Macmillan Pub. Co. NY.
7. Watson J.D. (1987) Molecular Biology of the Gene, 7th Edition. The Benjamin Cumming Publishing Company Inc.
8. Prescott L. M., Harley J. P. and Klein D. A. (2011) Microbiology, 8th Edition. MacGraw Hill Companies Inc.

Progressive Education Society's
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Second Year of B.Sc. Microbiology (2020 Course)
Course Code: 24ScMicU4102
Course Name: Lab Course on 24ScMicU4101

Teaching Scheme: TH: 4 Hours/Week

Credit: 2

Examination Scheme: CIA : 20 Marks

End-Sem : 30 Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course Objectives:

- To study the effect of U.V. light on death rate of bacteria
- To introduce the concept of measurement of microbial cell dimensions by micrometry
- To enrich students with knowledge of microbial air diversity and air flora settling velocity.
- To understand the parameters used to study drinking water and wastewater

Course Outcomes:

- On completion of the course, student will be able to–
- Measure microbial cell dimensions by micrometry.
- Learn the methods for isolation of bacterial mutants.
- Determine microbial diversity of air

Major Core Practical

Course Contents:

Sr. No	Name of the practical	No. of practical's
1	Measurements of cell dimension by micrometry using all the objectives	2
2	AirFlora: 1. Diversity determination. 2. Simpson index 3. Settling velocity determination	2
2	a. Induction of mutations by using physical mutagen (e.g. UV rays) or chemical mutagen (e.g. HNO ₂) (demonstration) b. Isolation of mutants by any suitable method Demonstration of UV survival curve	4
3	Water Microbiology 1. Bacteriological tests of potability of water a. MPN, Confirmed and Completed test. b. Membrane filter technique (Demonstration) 2. Determination of B.O.D. of water sample 3. Determination of total solids and total suspended solids in sewage water	7

References:

1. Standard Methods for the Examination of Water and Wastewater (2005) 23rd Edition, Publication of the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton, Mary Ann H Franson.
2. Tiwari R. P., Hoondal G. S., & Tewari R. (2009). 1st Edition, Laboratory techniques in Microbiology and Biotechnology. Abhishek Publications
3. Prescott, H. (2002). Laboratory exercises in Microbiology 5th edition.
4. Pelzar M. J., Chan E. C. S., Krieg N. R. (1986) Microbiology. 5th Edition, McGraw-Hill Publication.

Progressive Education Society's
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Second Year of B.Sc. Microbiology
(2020 Course)

Course Code: 24ScMicU4501

Course Name: Lab Course on Food Microbiology

Teaching Scheme: TH: 4 Hours/Week

Credit: 2

Examination Scheme: CIA : 20 Marks

End-Sem : 30 Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course objective:

- To understand the important developments in food and its scope.
- To know about pathogenic, non-pathogenic and useful microorganisms in the food industry.
- To become aware about the testing methods routinely used for testing food quality.
- To understand the students about common causes of food spoilage.
-

Course outcomes:

On completion of the course, student will be able to–

- Students will be able to describe the role of microorganisms in the production of food and its Spoilage
- Students will develop experimental skills for testing different foods for the presence of microorganisms

VSC P(2)

Course Contents:

Sr. No	Name of the practical	No. of practical's
1	Enumeration of microbial load in food samples by spread/pour plate technique.	2
2	a. Isolation and identification of any food borne pathogen from food products. b. Isolation and identification of microorganisms from spoiled vegetables/fruits. c. Isolation and identification of spoilage microorganisms from bread.	6
3	a. Isolation and identification of lactic culture upto genus level b. Antifungal activity of lactic acid bacteria c. Preparation of Yogurt/Dahi d. Determination of TDP and TDT	7

References:

1. Banwart G. J. (1989). Basic Food Microbiology, 2nd Edn. Chapman and Hall, International Thompson Publishing.
2. Thomas J. Montville, Karl R. Matthews, and Kalmia E. Kniel (2017) Food Microbiology: An Introduction" 4th edition
3. Clarence Henry Eckles, Willes Barnes Combs, Harold Macy (1943). Milk and milk products, 4th Ed. McGraw-Hill Book Company, Incorporated.

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5. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha (2013). Food Microbiology, 5th Edn. McGraw-Hill Education, India.
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Second Year of B.Sc.

Microbiology
(2020 Course)

Course Code: 24ScMicU4301

Course Name: Air and Water Microbiology

Teaching Scheme: TH: 4 Hours/Week

Credit: 2

Examination Scheme: CIA : 20 Marks

End-Sem : 30

Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course Objectives:

- Understand the varied air and water microflora
- Understand the methods to determine the microorganisms present in air and water
- To get versed with the techniques to treat and prevent air and water pollution

Course Outcomes:

On completion of the course, student will be able to–

- Identify the microbes in air and water and the diseases associated with it
- Get versed with the diversity of microbes present around us and will be able to determine them.
- Learn new ways to determine microbes from a raw sample.

Minor (T/P)(2+2 or 4)

Course Contents:

Unit I	Air Microbiology	No. of Lectures
	A. Air flora ● Transient nature of air flora ● Droplet, droplet nuclei, and aerosols B. Air pollution ● Chemical pollutants, their sources in air and effects on human health C. Methods of Air sampling and types of air samplers ● Impaction on solids ● Impingement in liquid ● Sedimentation ● Centrifugation ● Precipitation ● Thermal Precipitation D. Air sanitation ● Physical and chemical methods ● E. Air borne infections.	15
Unit II	Water Microbiology	No. of Lectures
	A. Types of water ● Surface, ground, stored, distilled, mineral and demineralized water ● Water purification methods, Bacteriological	15

	standards of potable water ● Maharashtra pollution control board (MPCB), Central pollution control board (CPCB), Bureau of Indian standards (BIS), World health Organization (WHO) B. Water purification methods of drinking water C. 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> D. Bacteriological analysis of water for potability ● Presumptive coliform count ● Confirmed test ● Completed test ● Eijkman test ● Hydrogen sulphide paper strip test ● Membrane filter technique E. Domestic WasteWater ● Analysis of wastewater i. Physicochemical parameters: pH, temperature, total solids, suspended solids, Chemical Oxygen Demand ii. Biological parameters: Introduction to Biological Oxygen Demand, Toxicity (Fish bioassay) F. Industrial water pollutants, their ecological effects and health hazards ● Biomagnification and eutrophication G. Methods of effluent treatment ● Primary, secondary, tertiary treatment methods	
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References:

1. Daniel Lim., Microbiology, 2nd Edition; McGraw-Hill Publication
2. Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3rd Edition.
3. Thomson Brooks / Cole. Madigan M.T, Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
4. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata McGraw Publishing Co.
5. Tortora G.J., Funke B.R., Case C.L. (2006) Microbiology: An Introduction. 8th Edition.
6. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY
7. Pelczar M. J., Chan E. C. S., Krieg N. R. (1986) Microbiology. 5th Edition, McGraw-Hill Publication
8. Prescott, Lancing M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education
9. Hans G. Schlegel (1993) General Microbiology, 8th Edition, Cambridge University Press
10. Martin Frobisher (1937) Fundamentals of Microbiology, 8th Edition, Saunders, Michigan University press.
11. Standard Methods for the Examination of Water and Wastewater (2005) 23rd Edition, Publication of the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton,

Mary Ann H. Franson.

Progressive Education Society's**Modern College of Arts, Science and Commerce****(Autonomous), Shivajinagar, Pune - 5****Second Year of B.Sc. Microbiology (2020 Course)****Course Code: 24ScMicU4302****Course Name: Lab Course on 24ScMicU4301****Teaching Scheme: TH: 4 Hours/Week****Credit: 2****Examination Scheme: CIA : 20 Marks****End-Sem : 30****Marks****Prerequisite Courses: First Year B.Sc. Microbiology****Course Objectives:**

- To enrich students with knowledge of microbial air diversity and air flora settling velocity.
- To acquaint the students with different water quality analysis techniques.

Course Outcomes:**On completion of the course, student will be able to–**

- Determine microbial diversity of air.
- Analyze the quality of water by performing different techniques.

Minor (T/P)(2+2 or 4)**Course Contents:**

Sr. No	Name of the practical	No. of practical's
1	AirFlora: 4. Diversity determination. 5. Simpson index 6. Settling velocity determination	5
2	Water Microbiology 1. Bacteriological tests of potability of water a. MPN, Confirmed and Completed test. b. Membrane filter technique (Demonstration) 2. Determination of B.O.D. of water sample 3. Determination of total solids and total suspended solids in sewage water 4. Water microflora	10

References:

1. Standard Methods for the Examination of Water and Wastewater (2005) 23rd Edition, Publication of the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton, Mary Ann H Franson.
2. Tiwari R. P., Hoondal G. S., & Tewari R. (2009). 1st Edition, Laboratory techniques in Microbiology and Biotechnology. Abhishek Publications
3. Prescott, H. (2002). Laboratory exercises in Microbiology 5th edition.
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Second Year of B.Sc.
Microbiology
(2020 Course)**

Course Code: 24ScMicU4401

Course Name: Community Hygiene

Teaching Scheme: TH: 4 Hours/Week

Credit: 2

Examination Scheme: CIA : 20 Marks

End-Sem : 30

Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course Objectives:

- Appreciate different dimensions of health
- Understand the role of nutrition, physical fitness and healthy lifestyle in maintaining health and explain the different positive and negative influences on health.
- Create awareness about the importance of hygiene, personal and community health and recognize their interrelationship

Course Outcomes:

- On completion of the course, student will be able to–
- Define and classify diseases and explain the causes, symptoms and prevention of a few communicable and non-communicable diseases.
- Discuss the significance of immunity in preventing diseases
- Learn the approaches for conservation of environment.

GE/OE (T/P)

Course Contents:

Unit I	Health and Hygiene	No. of Lectures
	A. Concept of health ● What is health? ● Classification of health ● Personal health ● Domestic or family health ● Community or public health ● Environmental health B. Concept of hygiene 1. What is meant by hygiene 2. Classification of hygiene ● Domestic hygiene ● Community hygiene ● Environmental hygiene C. Pollution ● Types of pollution, their Causes and Effects D. Health Issues in the Community	10

	inadequate food, unsafe drinking water, lack of sanitation ● Current Local and Global Health Concerns Determinants/Causes of ill health :CDC, WHO ● Attitudinal and Behavioural changes ● Giving guidance and counselling Improving health literacy	
Unit II	Environmental Hygiene	No. of Lectures
	A. Prevention and Control of environmental Pollution B. Waste Management ● Biodegradable and Non-Biodegradable Waste ● Waste Disposal Methods and challenges C. Water, Health and Sanitation.... ● Water Quality and Health Risks ● Water Conservation - Needs and Methods D. Eco-Friendly Agricultural Practices Biopesticides and Biofertilisers	20

References:

1. Joceline Pomerleau and Martin Mc Kee, (2006). Issues in public Health. Tata Mc Graw –Hill Publishing Company Limited, New Delhi
2. Megan Landon R. (2006). Environment, Health and Sustainable Development, Tata Mc Graw –Hill Publishing Company Limited, New Delhi.
3. Park, K. (2008). Essentials of community health nursing, Banarsidas Bhanot Publishers, Jabalpur

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Second Year of B.Sc.
Microbiology
(2020 Course)

Course Code: 24ScMicU4601

Course Name: Basics of fermentation technology

Teaching Scheme: TH: 4 Hours/Week

Credit: 2

Examination Scheme: CIA : 20 Marks

End-Sem : 30

Marks

Prerequisite Courses: First Year B.Sc. Microbiology

Course Objective :

- To understand the different types of fermentation processes, the optimization of fermentation parameters and the downstream process of fermentation

Course Outcomes:

On completion of the course, student will be able to–

- Understand the basics of large scale fermentation processes with respect to constituents of media and types of crude media.
- Understand the control and monitoring aspects in commercial bioprocess technology

SEC T (2)

Course Contents:

Unit I	Introduction to Industrial Microbiology	No. of Lectures
	A. Design, operations and processes involved in Fermenters Design of the equipment and operations of the parts, screening of microorganisms and strain improvement B. Media used in fermentation industry and sterilization a. Constituents of media b. Media optimization : Classical Approach, PB design, RSM, Taguchi design and Central Composite Design C. Types of fermentations SSF, SmF, Batch, fed batch and continuous fermentation	12
Unit II	Media Sterilization and Contamination	No. of Lectures
	A. Sterilization of media ● Methods of sterilization ● Batch and Continuous sterilization ● Concept of Del factor B. Contamination ● Sources, Effects and Precautions C. Concept of Scale up and Scale down ● Introduction to different levels of fermentation	18

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References:

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). *Principles of fermentation technology*. Elsevier.
2. Casida JR L. E. (2019) Industrial Microbiology, Second Edition, New Age International Publishers, New Delhi, India
3. Patel. A. H. (2011) Industrial Microbiology, Second edition, Macmillan India Ltd.
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5. Latest Indian Pharmacopia :<https://www.pharmdinfo.com/pharmacoepidemiology-and-pharmacoeconomics-f65/topic2081.html>