



# BIOFERTILIZERS & BIOPESTICIDES:

SCIENCE AND APPLICATION  
IN AGROECOSYSTEMS

*As per Latest Syllabus  
(UGC Prescribed NEP Curriculum)*

A Text Book for B. Sc. Hons.  
in Microbiology For

University of Calcutta  
University of Burdwan,  
Bankura University,  
Raiganj University,  
University of North Bengal &  
University of Kalyani.



● Dr. Tanmay Ghosh

● Mr. Rishin Bhattacharyya

● Dr. Joy Sarkar

# **BIOFERTILIZERS AND BIOPESTICIDES: SCIENCE AND APPLICATION IN AGROECOSYSTEMS**

**Dr. Tanmay Ghosh**

Assistant Professor,  
Department of Microbiology, Dinabandhu Andrews College,  
University of Calcutta.

**Mr. Rishin Bhattacharyya**

M.Sc

**Dr. Joy Sarkar**

FLS.

Associate Professor, Department of Botany,  
Dinabandhu Andrews College, Garia, Kolkata,  
Affiliated to the University of Calcutta.

**Kripa-Drishti Publications, Pune.**

Book Title: **Biofertilizers and Biopesticides: Science and Application in Agroecosystems**

Authored By: **Dr. Tanmay Ghosh, Mr. Rishin Bhattacharyya  
Dr. Joy Sarkar**

**Price: ₹699**

1<sup>st</sup> Edition

ISBN: **978-81-976840-9-8**



Published: **August 2024**

**Publisher:**



**Kripa-Drishti Publications**

A/ 503, Poorva Height, SNO 148/1A/1/1A,  
Sus Road, Pashan- 411021, Pune, Maharashtra, India.  
Mob: +91-8007068686  
Email: editor@kdpublishations.in  
Web: <https://www.kdpublishations.in>

© **Copyright Dr. Tanmay Ghosh, Mr. Rishin Bhattacharyya, Dr. Joy Sarkar**

All Rights Reserved. No part of this publication can be stored in any retrieval system or reproduced in any form or by any means without the prior written permission of the publisher. Any person who does any unauthorized act in relation to this publication may be liable to criminal prosecution and civil claims for damages. [The responsibility for the facts stated, conclusions reached, etc., is entirely that of the author. The publisher is not responsible for them, whatsoever.]

## **PREFACE**

From deepest of our heart containing the warm pleasuring well wishes we are feeling very lucky and honored, to present you the thoroughly revised, willingly prepared and studied with high efforts, the first edition of. We hope the book will become helpful to all the readers of this book who have taken it as a source of knowledge what they seek for. The book is written with immense hard work; dedication and desperation. We have tried to put all the information available on these topics for the readers and tried to make it as easy as possible for the easy and correct understanding of the topics by readers. The book is written with dedicated practices of restless work with determination and passion for the writing of a book helpful on this subject. The book is containing the information mostly for the students but we do believe that it can also be helpful for everyone.

The book is consisting 4 Units all together in it. The unit 1 is focusing on the topic on Biofertilizers & their types and Field. The unit 2 is containing the about Phosphate Solubilizing Microorganism & their field Applications. Mycorrhizal Biofertilizers & their types are widely discussed in unit 3. The details on the Bio pesticides and their Cultivation & application is described in unit 4.

At first we wish to thank to our parents who become the pillars of our life on which we are standing. Therefore want to thank our students and well-wishers for standing.

We are also thankful to the publishers for the speedy and quality production.

### **Authors**

Dr. Tanmay Ghosh

Mr. Rishin Bhattacharyya

Dr. Joy Sarkar

## **Abbreviations**

Arbuscular Mycorrhiza (AM)  
Arbuscular Mycorrhizal Fungi (AMF)  
Biological Nitrogen Fixation (BNF)  
Blue-Green Algae (BGA)  
B-Polyhydroxybutyrate (PHB)  
Cytoplasmic Polyhedrosis Viruses (CPV)  
Dichlorodiphenyltrichloroethane (DDT)  
Dissolved Organic Carbon (DOC)  
Ectomycorrhizal Fungi (EMF)  
Electrical Conductivity (EC)  
Farmyard Manure (FYM)  
Giant Unilamellar Liposomes/Vesicles (GUVs)  
Glucose Peptone Agar Test (GPA test)  
Large Unilamellar Liposomes/Vesicles (LUVs)  
National Biofertilizer Development Centre (NBDC)  
Next Generation Sequencing (NGS)  
Nuclear Polyhedrosis Virus (NPV)  
Phosphate Solubilizing Microorganisms (PSM)  
Phosphorus(P)  
Pikovaskaya's Agar Medium (PVK)  
Plant-Incorporated Protectants (PIPs)  
poly-B-hydroxybutyrate (PBH)  
Regional Biofertilizer Development Centres (RBDCs)  
Small Unilamellar Liposomes/Vesicles (SUVs)  
Vesicular Arbuscular Mycorrhiza (VAM)  
yeast Extract Mannitol Agar (YEMA)

# INDEX

<b>Unit 1: Biofertilizer</b> .....	<b>1</b>
1.2 Symbiotic Nitrogen-Fixation: .....	20
1.2.1 Rhizobium Bio-Fertilizers: .....	21
1.2.2 <i>Frankia Bio-Fertilizers</i> : .....	28
1.2.3 <i>Alnus</i> : .....	30
1.2.4 Casurina plants:.....	31
1.2.5 Blue-Green Algae (Cyanobacteria) as Bio-Fertilizer: .....	32
1.2.6 <i>Azolla sp. Bio-Fertilizers</i> : .....	37
1.3 Nitrogen Fixation: .....	44
1.3.1 Non-Biological: .....	45
1.3.2 Biological: .....	46
1.4 Non-Symbiotic Nitrogen Fixers: .....	47
1.4.1 <i>Azotobacter</i> :.....	48
1.4.2 <i>Azospirillum spp</i> : .....	52
1.5 Reference: .....	60
<b>Unit 2: Phosphate Solubilizers</b> .....	<b>64</b>
2.1 Introduction:.....	64
2.1.1 Importance of Phosphorus in Plants: .....	65
2.2 Phosphate Solubilizing Microbes:.....	66
2.2.1 Isolation of Phosphate Solubilizing Microorganisms: .....	68
2.2.4 Mechanism of Phosphate Solubilizers: .....	69
2.2.2 Characterizations of Phosphate Solubilize:.....	74
2.2.3 Mass Production of Phosphate Solubilizing Microorganisms:.....	75
2.2.4 Field Application of Phosphate Solubilizers: .....	76
2.2.5 Advantages of Phosphate Solubilizing Microorganisms: .....	77
2.2.6 Disadvantages of Phosphate Solubilizing Microorganisms: .....	77
2.3 Reference: .....	78
<b>Unit 3: Mycorrhizal Bio-Fertilizer</b> .....	<b>82</b>
3.1 Introduction:.....	82
3.1.1 Mycorrhizae:.....	83
3.1.2 Characteristics of Mycorrhizae:.....	84
3.1.3 Function of Mycorrhizae: .....	85
3.2 Importance of Mycorrhizae: .....	86
3.2.1 Mycorrhizal Inoculum:.....	90
3.2.2 Disadvantages of Mycorrhizae as Bio fertilizer: .....	95

3.3 Types of Mycorrhizae:.....	96
3.3.1 Endomycorrhizae: .....	97
3.3.2 Ectomycorrhizae: .....	120
3.4 Reference: .....	126

**Unit 4: Bioinsecticides ..... 129**

4.1 Introduction:.....	129
4.2 Synthetic Biopesticides:.....	132
4.2.1 Advantages of Bioinsecticides Over Synthetic Pesticides: .....	132
4.2.2 Useful Microbes:.....	134
4.2.3 Bacteria:.....	134
4.3 <i>Bacillus Thuringiensis</i> : .....	134
4.3.1 Isolation and culture of <i>Bacillus Thuringiensis</i> : .....	136
4.3.2 Production of <i>Bacillus Thuringiensis</i> :.....	137
4.3.3 Mode of Action:.....	140
4.3.4 Field Application: .....	145
4.3.5 Other <i>Bacillus</i> species: .....	145
4.4 Virus: .....	146
4.4.1 Granulosis Virus: .....	147
4.4.2 Genetically Engineered Viruses:.....	148
4.4.3 Cultivation: .....	149
4.5 Reference: .....	152



## ABOUT THE AUTHORS



**Dr. Tanmay Ghosh**, presently working as Assistant Professor, Department of Microbiology, Dinabandhu Andrews College, University of Calcutta. He completed his early study from Tarakeswar High School. He has completed his Master Degree in Microbiology from The University of Calcutta in 2009 and in 2022 he has obtained his Ph.D. Degree in Microbiology from NIT Durgapur. He has completed his Post Doctoral (Doctor of Science) Degree in Microbiology from California Public University (United states of America) in 2023. Dr. Ghosh Started his Professional Career as a lecturer of Microbiology at Rabindra Mahavidyalaya, Champadanga, Hooghly, University of Burdwan in the year 2009. He then shifted to Dinabandhu Andrews College, Garia, Kolkata in 2019 has been acting as an Assistant Professor of Microbiology. He has been engaged in teaching and research for fifteen years. Dr. Ghosh has published More than 70 papers in Scopus, Web of science, Elsevier, Springer, Pubmed, Peer-reviewed Journal & in many UGC care listed journal and is a regular contributor of research papers in different Journal of National and International reputed. He has achieved total 5 Patent (1 UK Patent). He

is one of the authors of the some popular books like "PLANTS: Antibacterial Potential and Role in Disease Management"; "Microbial Disease with its Modern Diagnostic Techniques"; "A Fundamental Book on Plant Pathology"; "Fundamental Book of Food and Dairy Microbiology"; "Training and Development Survey at BSNL"; "Essential and Fundamental Book of Immunology"; "I 23- Inheritance of Human Genetics"; "Management Method of Insect-Pest"; "Recent Advances In Research of Bacterial Endophytes and their Roles as Ameliorators of Abiotic and Biotic Stresses"; "MILLET'S MAGICAL CROPS"; Essentials of Microbiology etc. He has successfully performed the role of Editor of "International Journal of Advanced Scientific Research." (Indexed Journal, Refereed Journal, Peer-Reviewed Journal). He also awarded several prestigious awards like Hooghly Ratna award, BHARAT GAURAV PURASKAR, SENIOR SCIENTIST AWARD, Certificate of Excellence Award, Young scientists Award In Recognition Of Outstanding Professional Research Achievements, SWAMI VIVEKANANDA EXCELLENCE AWARD 2023, Netaji Subhas Chandra Bose Memorial Award 2024, RASTRIYA SEVA SAMMAN 2023, Awarded In Recognition Of Outstanding Professional Research Achievements In the Field of Microbiology. He is selected as a Fellow of THE LINNEAN SOCIETY OF LONDON in 2024. He also selected as a Member of ROYAL SOCIETY OF BIOLOGY in 2024. He achieved the Membership of BRITISH SOCIETY FOR ANTIMICROBIAL CHEMOTHERAPY. He also get several Reviewer awards like Best Reviewer On International Journal Of Basic And Applied Sciences Journal On December 2020, Best Reviewer for the journal South Asian Research Journal of Biology and Applied Bioscience Journal On October 2023. He has been designated as a Royal Fellow of the International Organization for Academic and Scientific Development (IOASD) on 8th November, 2023. His area of specialization is Microbiology, Biotechnology, Biochemistry, Agricultural Microbiology, Environmental Microbiology, Immunology, Plant Pathology etc and the field of research is Agricultural Microbiology, Seed Microbiology, Plant Pathology, Mycology, Agricultural Pathology, Environmental Microbiology etc.



**Mr. Rishin Bhattacharyya** holds a robust academic background, having completed his B.Sc. and M.Sc. degrees in Botany from Brahmananda Keshab Chandra College, Baranagar, affiliated to West Bengal State University. He has actively presented conference papers at various inter-college and state-level seminars. His scholarly contributions extend internationally with a publication titled "Evaluation of antibacterial efficacy of different extracts of *Ocimum gratissimum* L. (Lamiaceae) leaves against some pathogenic bacteria with phytochemical screening (2019)" in the International Journal of Pharma and Biosciences. Professionally, Rishin has expanded his expertise through multiple certificate courses and training programs. Notably, he has completed "Basic Tools in Biotechnology" supported by BIRAC, a Government of India Enterprise, and gained specialized knowledge in "Geo-spatial Applications for Forest Ecosystem Analysis", "RS & GIS Applications", and "Basics of Geocomputation and Geoweb Services" from the Indian Institute of Remote Sensing (IIRS), Dehradun, and the Indian Space Research Organisation (ISRO). He has also undergone intellectual property training organized by the Intellectual

Property Office, Government of India. In addition to his academic and professional pursuits, Rishin Bhattacharyya has a keen interest in plant genetics, demonstrating his dedication to advancing knowledge in this specialised field.



**Dr. Joy Sarkar** is presently an Associate Professor of Department of Botany, Dinabandhu Andrews College, Garia, Kolkata affiliated under the University of Calcutta. He has completed his Master degree in Botany from Darjeeling Govt. College in 2004 with distinction and in 2017 he has obtained his Ph.D. degree in Botany from University of Calcutta. Dr. Sarkar started his professional career as an Assistant Teacher at Bararangrash Dineswari High School (Cooch Behar, West Bengal) in the year 2006. He then shifted to Dinabandhu Andrews College in 2008 as a lecturer of Botany and has been acting as an Assistant Professor from 2010 to 2022. Later on, he promoted to Associate Professor in the year of 2022. He has been engaged in teaching and research for more than fifteen years. Dr. Sarkar has published more than 40 papers in various peer reviewed Journals and is a regular contributor of research papers in different Journal of National and International reputed. He is one of the authors of the popular book "Mushroom Cultivation Technology". He has been elected as Fellow of the Linnean Society of London in 2020. He has successfully performed the role of Editor of various International Journals (Indexed in

Scopus & Web of Science). He was the Principal Investigator of one UGC-Sponsored research project. His area of specialization is Mycology and Plant Pathology and the field of research is Green Nanotechnology.



**Kripa-Drishti Publications**

A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk,  
Pune - 411021, Maharashtra, India.

Mob: +91 8007068686

Email: editor@kdpublishations.in

Web: <https://www.kdpublishations.in>

Price: ₹ 699

ISBN: 978-81-976840-9-8



9 788197 684098