

Molbio FronTiers

– From Structure to Analysis



Molbio FronTiers

– From Structure to Analysis



Prof.(Dr.) Arijit Chatterjee

Assistant Director (Microbiology)

National Centre for Disease Control (NCDC)

Ministry of Health & Family Welfare Directorate General of Health
Services, Government of India

6G, Rani Rashmani Garden Lane, P.O. Tangra, Kolkata – 700015
(West Bengal), India

Molbio Frontiers

- From Structure to Analysis

Author(s) : Prof.(Dr.) Arijit Chatterjee

ISBN : 978-81-69623-07-0

Page(s) : 192

Published Year : 2026

Published by : Excellent Publishers
No. 38/48, Second street, Ellappa Nagar
Kanchipuram – 631501, Tamilnadu, India.
Cell +91-9842641794
excellentpublishers2013@gmail.com
www.excellentpublishers.com



Disclaimer :

The author is solely responsible for the contents of the book in this volume in any manner, Errors, if any are purely unintentional and readers are requested to communicate such errors to the authors to discrepancies in futures.

Note: No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Copyright © 2026 Excellent Publishers, All Rights Reserved

PREFACE

Dear Reader,

The rapidly evolving field of molecular biology continually drives advances in our understanding of genetics and its application in medicine, forensic science, and biotechnology. This book aims to furnish readers with a solid foundation in both the theoretical principles and practical techniques that underpin modern genetic analysis and manipulation. Beginning with the chemical and structural basis of nucleic acids, it progresses thoughtfully through the mechanisms of gene expression and regulation, revealing how life's molecular instructions are faithfully transmitted and executed. Emphasis on critical laboratory methods such as PCR variants, DNA sequencing, and electrophoretic separations highlights the tools scientists use to decode and harness genetic information. Furthermore, discussions on specialized methods like immunofluorescence assays and pulsed-field gel electrophoresis illustrate their significance in research and clinical diagnostics. By presenting complex topics in an accessible yet detailed manner, enriched by current scientific insights, this work aims to empower readers to confidently engage with molecular biology's challenges and opportunities in diverse scientific contexts.

Sincerely,

Prof.(Dr.) Arijit Chatterjee

About Author(s)

Prof.(Dr.) Arijit Chatterjee



Prof.(Dr.) Arijit Chatterjee started his career at 'Cancer Centre Welfare Home & Research Institute' Kolkata - 700064 as In-Charge in The Department of Microbiology. Later, he joined 'SRL Reference Laboratory' Kolkata, in 2008 as a **Senior Scientific Officer** in The Department of Microbiology & Tuberculosis Laboratory. He worked there for about 6 years and contributed towards research in general as well as in tuberculosis bacteriology. Then, he joined '**Intermediate Reference Laboratory**', Kolkata, in '**Dr. B. C. Roy Post Graduate Institute of Paediatric Sciences**' and contributed his knowledge to provide support to '**Revised National Tuberculosis Control Programme**' under **FIND-WHO** as a **Technical Officer** in Biosafety Level 3 & LPA Laboratory. Then he joined '**Madhusthali Institute of Paramedical Sciences**' (MCKV Group of Institution) as **Principal** and as **Consultant Molecular Biologist** in '**Medinova Diagnostic Services Pvt. Ltd.**' (NABL) and contributed largely in COVID19 research work. He joined as the member of the '**Executive Council**' and **Principal** in '**Kingston College of Science**', Barasat, Kolkata in 2021.

Later on he shifted to Tripura and joined as the **Principal** in the **Faculty of Allied Health Science, The ICFAI University Tripura**, and also holding the honour of the **‘Chief Head Examiner’** of Clinical Microbiology, General Biochemistry, Haematology & Immunology in MAKAUT, Govt. of WB from 2024-26.

He got the opportunity to serve The Govt. of India in 2025 as **Senior Consultant (Head)** of the **National Programme Management Unit (NPMU)** in **National Centre for Disease Control (NCDC)**, MoH&FW, DGHS, GoI in New Delhi for **Establishment & Strengthening of NCDC State Branches for Pandemic Preparedness** under **PM-ABHIM (Pradhan Mantri Ayushman Bharat Health Infrastructure Mission)**.

Presently He is working as an **‘Assistant Director’ (Microbiology)** at **National Centre for Disease Control (NCDC), West Bengal Branch**.

He Studied M.Sc in Microbiology and did his PhD in Science covering his research work in TB. He completed his MBA in Healthcare & Hospital Management, Certificate in Human Molecular Genetics from IIT Kanpur, Certificate in Cryo Electron Microscopy from IICB, Kolkata, Teaching And Learning in General Program from IISc Bangalore, CNAACA from NITTTR, Chennai.

He is the Editor of IJMRD & Editorial Member of IJMRD, VITP-IJMBR, VITP-IJHER, Reviewer of South Asian Research Journal of Biology and Applied Bioscience and Saudi Journal of Pathology and Microbiology.

He won Education Eminence Award 2021 from News 18 Bangla by the Minister of State Technical & Vocational Education, Best Faculty Award from INSA 2021 (Engineering, Science and Medicine), Academic Excellence Award 2021 by Novel Research Academy, CV Raman Prize 2022 and Distinguished Professor Award 2024 by Institute of Researchers, Best Innovative Researcher Award 2024-25 by MSME, Govt. of India. He

was awarded '**Fellow of International Association of Medical and Health Research (FIAMR)**' for his outstanding contribution in the field of medical and health research in the form of several scientific research publications.

He is the member of **IAMM, ASM and 'European Society of Clinical Microbiology & Infectious Diseases', Basel, Switzerland**. He has several Scientific Research Publications in reputed National and International journals.

He authored a book entitled '**A Complete Guide to Antibiotics**' which is available online in Amazon, published by Akinik Publication, New Delhi.

Synopsis

The rapidly evolving field of molecular biology continually drives advances in our understanding of genetics and its application in medicine, forensic science, and biotechnology. This book aims to furnish readers with a solid foundation in both the theoretical principles and practical techniques that underpin modern genetic analysis and manipulation. Beginning with the chemical and structural basis of nucleic acids, it progresses thoughtfully through the mechanisms of gene expression and regulation, revealing how life's molecular instructions are faithfully transmitted and executed. Emphasis on critical laboratory methods such as PCR variants, DNA sequencing, and electrophoretic separations highlights the tools scientists use to decode and harness genetic information. Furthermore, discussions on specialized methods like immunofluorescence assays and pulsed-field gel electrophoresis illustrate their significance in research and clinical diagnostics. By presenting complex topics in an accessible yet detailed manner, enriched by current scientific insights, this work aims to empower readers to confidently engage with molecular biology's challenges and opportunities in diverse scientific contexts.

This book provides a comprehensive exploration of the molecular biology techniques essential for understanding the structure, function, and dynamics of DNA and RNA. It covers fundamental concepts such as the detailed composition and organization of DNA, the central dogma of molecular biology explaining genetic information flow, and the sophisticated mechanisms involved in DNA replication, transcription, and translation. Additionally, the book delves into modern molecular biology tools and applications including PCR (Polymerase Chain Reaction) techniques, DNA fingerprinting, various sequencing methods like Sanger and Next Generation Sequencing, and nucleic acid analysis methods such as electrophoresis and blotting techniques. By integrating detailed explanations with clear illustrations and practical applications, this text is designed to support students, researchers, and professionals in biosciences and medical fields seeking to deepen their knowledge and practical skills in molecular genetics and biotechnology.

Table of Contents

Chapter No.	Contents	Page No.
1	Structure and Components of DNA	1-7
2	Central Dogma and the Genetic Code	8-15
3	Enzymes Involved In DNA Replication	16-30
4	Restriction Fragment Length Polymorphism (RFLP): Steps	31-35
5	DNA Replication: Steps and Mechanism	36-41
6	DNA Transcription: Steps and Mechanism	42-47
7	DNA Fingerprinting: Steps and Applications	48-52
8	Sanger Sequencing Method: Principle and Steps	53-58
9	Next Generation Sequencing: Principle, Steps Involved, and Applications	59-66
10	Types of RNA: Structure and Functions	67-72
11	RNA Translation: Major Steps of Protein Synthesis	73-79
12	Polymerase Chain Reaction (PCR): Steps, Types, Applications	80-120
13	Loop-Mediated Isothermal Amplification (LAMP)	121-126
14	Southern Blotting: Principle, Steps, Applications	127-130
15	Northern Blotting: Objective, Principle, and Procedure	131-133
16	Exons and Introns: Functions and Types	136-138
17	Electrophoresis: Principles, Types, and Uses	139-144
18	Capillary Electrophoresis: Principle and Application	145-151
19	Immunofluorescence Assay: Principle, Steps, Types, and Uses	152-156
20	Pulsed-Field Gel Electrophoresis (PFGE): Steps, Applications	157-160
21	Agarose Gel Electrophoresis: Principle, Procedure, Results	161-166
	Glossary	167-170
	References	171-176
	Bibliography	177-178
	Index	179

Index

1. **Agarose Gel Electrophoresis** – Principle, preparation, procedure, factors affecting DNA migration, staining, visualization. (Pages: 205–211)
2. **Central Dogma and Genetic Code** – Fundamental concept of genetic information flow, codon chart, wobble hypothesis, relation to transcription and translation. (Pages: 11–17)
3. **DNA Structure and Components** – Description of DNA, double helix, components like phosphoric acid, deoxyribose sugar, nitrogenous bases, and DNA forms (A, B, Z). (Pages: 1–9)
4. **DNA Polymerases** – Types, structure, functions in DNA replication and repair, differences in prokaryotic and eukaryotic DNA polymerases. (Pages: 26–37)
5. **DNA Replication** – Mechanism, steps (initiation, elongation, termination), enzymes involved (helicase, topoisomerase, primase, ligase), prokaryotes vs eukaryotes. (Pages: 51–58)
6. **Electrophoresis Techniques** – Principles, types (agarose, polyacrylamide, capillary), instruments, advantages, and applications. (Pages: 188–198)
7. **Exons and Introns** – Functions, types, roles in gene expression and evolution, difference between exons and introns. (Pages: 184–187)
8. **Immunofluorescence Assay** – Principle, steps, types (direct, indirect, multiplex), benefits, and limitations in protein detection. (Pages: 199–201)
9. **Loop-Mediated Isothermal Amplification (LAMP)** – Principle, mechanism, advantages, applications, and limitations in nucleic acid amplification. (Pages: 173–177)
10. **Northern Blotting** – Objective, principle, materials, procedure, advantages and disadvantages in RNA detection. (Pages: 181–184)
11. **Polymerase Chain Reaction (PCR)** – Principles, steps, types (real-time PCR, nested PCR, multiplex PCR, RT-PCR), primer design, applications, advantages and limitations. (Pages: 115–172)
12. **Pulsed-Field Gel Electrophoresis (PFGE)** – Steps, principle, applications, comparison with conventional electrophoresis. (Pages: 202–205)
13. **Restriction Fragment Length Polymorphism (RFLP)** – Steps, principle, applications, advantages and disadvantages. (Pages: 45–51)
14. **Sanger Sequencing Method** – Principle, components, steps, electrophoresis, advantages, and limitations. (Pages: 75–83)
15. **Structure and Types of RNA** – mRNA, tRNA, rRNA, and other non-coding RNAs, roles and structures. (Pages: 97–104)
16. **Topoisomerase** – Types, structure, catalytic mechanism, functions in DNA metabolism, and therapeutic relevance. (Pages: 38–45)
17. **Translation (Protein Synthesis)** – Major steps: activation of amino acids, initiation, elongation, termination, post-translational modification. (Pages: 104–114)

Molbio Frontiers

- From Structure to Analysis

Prof.(Dr.) Arijit Chatterjee



Excellent Publishers
Kancheepuram, Tamilnadu, India
www.excellentpublishers.com

