PREFACE

Molecular Biology is a rapidly evolving field of Biological Science that has revolutionized our understanding of life and its intricate mechanisms. The discovery of DNA's structure and function has led to tremendous advancements in biotechnology, medicine, and agriculture. As a result, there is a growing need for a comprehensive resource that provides a clear and concise introduction to the fundamental principles of Molecular Biology. This book, "**Essentials of Molecular Biology**," aims to fill this gap by providing an accessible and engaging overview of the field.

Written for students, researchers, and professionals, this book covers the core concepts, techniques and applications of Molecular Biology. From the structures and functions of nucleic acids to gene expression, regulation and manipulation, this book provides a thorough understanding of the molecular mechanisms that underlie life.

The text is designed to be a valuable resource for those new to the field, as well as a refresher for those looking to update their knowledge. Each chapter is structured to provide a clear and concise explanation of the topic, accompanied by illustrations to reinforce key concepts. I hope that this book will serve as a useful guide for readers seeking to understand the fascinating world of Molecular Biology and its many applications.

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CHAPTER ONE

INTRODUCTION TO MOLECULAR BIOLOGY

1.1 DEFINITION OF MOLECULAR BIOLOGY

Molecular Biology is the branch of biology that studies the structure and function of nucleic acids and proteins. It is the study of the structure and function of molecules and macromolecular systems associated with the molecular basis of inheritance and protein synthesis. Since genes are integral component of DNA, they are also studied in Molecular Biology. However, the adjective "Molecular" before Biology does not refer to all molecules of living organisms but only to the two crucial ones: *nucleic acids* and *proteins*.

Molecular Biology is closely related to Biochemistry and Genetics. Molecular Biology is not the study of the molecules of living organisms. Biochemistry, also called Biological Chemistry, fits this definition because it studies biological molecules and their chemical reactions in cells (metabolism). Molecular Biology is not the classical study of genes. This corresponds to Genetics, which deals with genes in relation to heredity and genetic variation. Molecular Biology involves the study of DNA, RNA, proteins and other cellular molecules that govern biological processes like gene expression and metabolism.

Molecular biologists are responsible for conducting experiments that focus on investigating the structure, function, processing, regulation and evolution of biological molecules (nucleic acids and proteins) and their interactions. This allows them to understand the workings of life at the micro level and how the structure of a molecule, including details such as the location and shape of a protein's active sites, affect its function.

1.2 METHODOLOGIES DEPLOYED IN MOLECULAR BIOLOGY

Molecular Biology is a reductionist approach to biological phenomena derived from Biochemistry and from Genetics and it has developed specific approaches such as Genetic Engineering, Structural approach and Bioinformatics in understanding the structure and functions of nucleic acids and proteins.

Genetic Engineering. Genetic Engineering (also known as Recombinant DNA Technology) is deployed to isolate genes, modify them *in vitro* and reintroduce them into organisms to investigate the physiological functions of genes and encoded proteins. Genetic Engineering is the basic tool that proves the physiological function of genes and proteins by generating gain-of-function and loss-of-function mutants. Basically, modifications of isolated genes are made "in vitro" to generate gain-of-function (higher expression or higher protein activity) or loss-of-function (knock out/null mutants or mutants with partial loss of function) and then these mutated genes are introduced into organisms by replacing the wild type copy. Phenotypes are investigated to ascertain what functions of the organism are modified.

Structural method. Molecular Biologists have also developed physical methods to determine the atomic structure and mechanism of these macromolecules (nucleic acids and proteins). In X-Ray Diffraction, ordered molecules in fibres or crystals give a three-dimensional atomic picture of nucleic acids and proteins. More recently, in Cryo-Electron Microscopy(cryo-EM), many pictures of single, unordered molecules at liquid helium temperature are combined to provide similar atomic pictures of macromolecules because at such low temperatures the molecules are static, and without