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GENOME SCIENCE

A Practical and Conceptual Introduction
to Molecular Genetic Analysis in Eukaryotes

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GENOME SCIENCE

A Practical and Conceptual Introduction
to Molecular Genetic Analysis in Eukaryotes

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Cold Spring Harbor Laboratory*

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GENOME SCIENCE

A Practical and Conceptual Introduction
to Molecular Genetic Analysis in Eukaryotes

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Front cover artwork: Metaphor for the puzzle of understanding the genomes of living things, represented by a base nucleotide sequence overlaid with an assembled set of chromosomes and gene model. Key organisms explored in narratives and laboratories are represented: Hominids, plants (*Arabidopsis* and maize), and the nematode worm *Caenorhabditis elegans*. Speckled corn kernels remind us that transposons are the major component of most advanced genomes. The fossilized Neanderthal skeleton is emblematic of the evolution of our species—and of our capacity to domesticate plants and contemplate the structure of our own genetic material.

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Preface

The DNA Learning Center's effort to develop lab experiments for high school and colleges dates to 1985, when Dave Micklos teamed with Greg Freyer to develop a sequence of experiments to make and analyze a recombinant DNA molecule. The initial testing was done in Rich Roberts' lab, well before he won the Nobel Prize, and incorporated key insights on inserting DNA into bacteria from the dean of transformation, Doug Hanahan. The lab sequence was initially a slim lab manual called "Recombinant DNA for Beginners," whose title was derived from the Graham Nash album "Songs for Beginners." It expressed perfectly our ideal of making complicated gene technology accessible to novices.

Within a year, we were training teachers across the country on summer tours of one, then two, Vector vans. These were customized Ford Econoline vans that packed enough equipment, reagents, and supplies to convert any general science lab into a molecular genetics lab. Along the way, we developed a complementary minitext that presented the concepts behind the labs, as well as extensions of recombinant DNA technology in basic and applied research. The much expanded work was formally published in 1991 as the Cold Spring Harbor Laboratory Press book *DNA Science*. That name, which Jim Watson threw out over lunch one day, seemed to capture the excitement of a new science based on the ability to manipulate and understand the DNA molecule.

DNA Science, now in its second edition, has sold more than 90,000 copies and is credited with helping to catalyze the movement to bring hands-on experiments with DNA into high school and beginning college classrooms. Two experiments found their way into the Advanced Placement biology curriculum, giving these experiments a nationwide audience. Stand-alone kits, developed with Carolina Biological Supply Company, reach well over 100,000 students per year.

The experiments in *DNA Science* are based exclusively on bacterial genetic systems. Now, *Genome Science* aims to take students to a higher level of biological and technological integration—to study the function of eukaryotic genes and genomes. Nineteen laboratories focus on four revolutionary technologies—polymerase chain reaction, DNA sequencing, RNA interference (RNAi), and bioinformatics—across three eukaryotic systems: humans, plants, and *Caenorhabditis elegans*. All labs stress the modern synthesis of molecular biology and computation, integrating in vitro experimentation with in silico bioinformatics. In addition to well-tested biochemical methods, *Genome Science* introduces *DNA Subway*, an intuitive bioinformatics platform that makes easy work of gene and genome analysis.

The four major technologies are organized into stand-alone chapters with extensive text introductions that place related labs into a common historical and conceptual framework. This modular approach provides options to develop new courses or to integrate labs into existing courses or student research. We especially hope that these protocols will help educators to extend research to classroom settings and distribute experiments in which multiple classes analyze and contribute to common data sets. DNA barcoding is especially amenable to “campaigns” in which many students contribute to understanding diversity within a common biogeographical unit.

Genome Science borrows many user-friendly features from its predecessor, including flow charts, marginal notes, reagent recipes, and extensive instructor information. To ease implementation, most labs are available as ready-to-use kits from Carolina Biological Supply Company. In addition, like its predecessor, *Genome Science* aims to help beginners use modern tools to explore the unseen world of genes and genomes.

In contemplating the cosmos in 1927, the great mathematical geneticist J.B.S. Haldane famously said, “My own suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose.” Had he been alive today, Haldane would almost certainly have the same suspicion about the genomes of higher organisms. In this sense, genome scientists are the new cosmologists of biology, uncovering the strange and beautiful structure of the genetic material that runs through all life.

Happy explorations.

DAVID MICKLOS

BRUCE NASH

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Cold Spring Harbor, New York

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