

# SEX, LOVE AND DNA



What Molecular Biology Teaches  
Us About Being Human



PETER SCHATTNER

SEX, LOVE AND DNA  
Peter Schattner

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# 1

## FROM PROTEINS TO PEOPLE



Can the discoveries of 21st-century molecular biology answer age-old questions about the human experience? Can studying proteins and DNA help us understand how we make our choices in sex and love? How we communicate? Where our emotions come from? Or why we age and die?

In the past such questions have generally been reserved for philosophers or psychologists. Some will argue that this is as it should be. Yet we are biological animals, and by studying biology, and especially the biology of cells and proteins and DNA, we can learn a lot about what it means to be human.

In this book I'll address these questions from the perspective of recent research in molecular biology, using stories and anecdotes that illustrate how the interactions of proteins and DNA shape an animal's life and how they affect the lives of people, as well.

### **DNA, PROTEINS AND BEHAVIOR**

If the idea that proteins and DNA influence who we are seems surprising, consider these examples:\*

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\* Some of the terms will be unfamiliar. Don't worry. They'll all be explained when we revisit these examples later.

- Prairie voles and meadow voles are closely related rodents, but male prairie voles are usually devoted monogamous mates, while meadow voles are promiscuous. This different behavior is largely the result of a single gene, AVPR1A, which is involved in the detection of a hormone called oxytocin. In fact, injecting prairie vole AVPR1A DNA into the brains of male meadow voles changes these promiscuous animals into devoted mates that are just as faithful as prairie voles.
- Fucose mutarotase is a protein that links a sugar molecule (called fucose) to other proteins. Although mice that can't produce fucose mutarotase are healthy and appear just like normal mice, the females display typical male sexual behavior. They mount other females and prefer to sniff female urine. Physically, they are 100% female. Yet disabling a single protein somehow switches their brain wiring to become what we might call "homosexual."
- Male zebra finches attract females by singing, with every young male zebra finch learning to sing the same song. But if a zebra finch is deficient in a protein called FOXP2, it is unable to learn how to correctly sing the usual finch song.
- Adding a gene can make a mouse smarter. When scientists administered an extra dose of DNA for a gene called NR2B to mice, they found that the mice solved mazes faster, and remembered the solutions longer, than their otherwise genetically identical litter mates.
- Male mice lacking a protein called MAO-A are more aggressive than other mice. If these mice are given a drug that compensates for their MAO-A deficiency, their aggressive behavior disappears.

It might be tempting to discount such animal experiments as irrelevant to understanding people and as merely confirming that humans are very different from animals. Since scientists can't do the same kinds of experiments on people, they can't directly determine whether similar biological effects occur in people. Nevertheless, indirect evidence increasingly suggests that animal experiments are relevant to understanding human behavior. Consider these recent discoveries:

- Autism is characterized by difficulties in expressing and receiving love and affection. Recent studies have linked some cases of autism to impaired oxytocin signaling, the same brain pathway that affects pair bonding in voles. Some physicians have even started treating autistic children with oxytocin. Although the causes of autism are still unclear,

a few autistic individuals have even been found with rare variants of the AVPR1A gene, the same gene involved in oxytocin signaling in voles.

- The adrenal gland uses a protein called 21-OH to produce the hormone cortisol. Approximately 1 out of 1500 women lack 21-OH, and their adrenal glands are unable to synthesize cortisol (a condition called congenital adrenal hyperplasia). Instead their glands synthesize testosterone, a hormone normally produced by men. Although testosterone's effects on women are still poorly understood, a recent study of sexual orientation was able to reach the "overwhelming conclusion" that women with congenital adrenal hyperplasia are more likely to be homosexual or bisexual than other women.
- In the 1990s, British researchers described a family that had severe language difficulties despite having normal intelligence, hearing and vocal chords. Genetic analysis revealed that all the afflicted family members shared a defective variant of the protein FOXP2, the same protein that was later shown to be critical for proper singing in zebra finches.
- Some individuals suffering from intellectual disability have nonfunctional variants of NR2B, the same gene that was inserted into the DNA of the super-smart mice. In addition, genetic studies of people with severe intellectual disability have found mutations in genes that interact closely with NR2B. Recently, researchers have also discovered the first genetic variant linked with IQ scores of healthy people, suggesting that differences in brain biochemistry contribute not only to intellectual disability but also to variations in normal intelligence.
- In 1993, scientists from the Netherlands reported on a family that included eight men, all of whom were violent or impulsively aggressive. Each of these men had a disabling variant in the MAO-A gene, the same gene linked to increased aggression in male mice. This particular genetic variant is extremely rare, but other more common MAO-A variants have since been discovered and also appear to be linked to susceptibility to violent behavior.

These examples illustrate how genes and proteins influence what sort of people we become. Occasionally a single inherited genetic variation can dramatically affect us. Some traits, such as intelligence or height, are influenced by hundreds of genetic variants. In other cases, environmental factors are more important than genetic ones. Yet here as well, scientists are learning that our environment affects us through changes in our DNA and proteins.

## ABOUT THIS BOOK

In this book, you'll learn how genetics and the environment interact on the level of cells and how those interactions affect our lives. Each new concept, however elementary, will be explained as it is encountered, so even if you have no background in molecular biology or genetics, you shouldn't have any problem following the explanations in the book. I'll describe biological phenomena using everyday language, rather than with the specialized words and abbreviations used in the scientific and medical literature. When a specialized scientific word does make communicating easier, it will be defined right away or included in the glossary.\* And don't worry; you won't be reading a dry biology textbook. You'll be learning biology through stories: stories of people who don't feel pain because of rare genetic variants and children whose DNA enables them to perform unusual feats of strength. Individuals whose genes have given them healthy lives past the age of 100, and people who can't speak or read simply because they lack certain proteins.

To ease our journey into the brave new world of molecular biology, the book is divided into six parts that build upon one another to tell a unified story. We'll begin our explorations by learning about proteins and their central role in life and get an introduction to DNA and genes, the blueprints for building proteins. In Part II of the book, the emphasis will turn more specifically to DNA and the way it provides a window into the past and the future. Part III focuses on genes and introduces RNA, the key intermediary molecule between genes and proteins. The way that our environment affects us is the central topic of Part IV. We'll learn about chromosomes and how the environment affects them, thus altering the genetic recipes that we inherited from our parents. By Part V, we'll be ready to appreciate what modern biology is teaching scientists about the ancient debate between "nature" and "nurture." We'll see how animal experiments, as well as human genetic studies, can disentangle the effects of heredity and environment on our proteins and on our lives. Finally, in Part VI, the various threads of DNA and protein, as well as RNA and chromosomes, will be tied together in a series of chapters illustrating how the world of molecular biology affects our behavior and our emotions.

Although you won't need any scientific background to understand *Sex, Love and DNA*, you should bring an active curiosity and a willingness to

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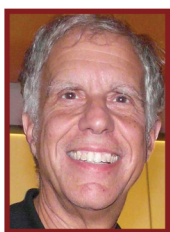
\* The exception is the abbreviations used for gene and protein names. Because these names are typically assigned long before scientists know a gene's or protein's function, they usually convey little information, and abbreviations work just as well.



stretch your mind. That said, the amazing world of molecular biology that you are about to enter will make the effort worthwhile. Beyond simply enjoying how the collective human mind has unraveled so much of how we function, you will learn to read about the latest scientific breakthroughs with a more critical eye, becoming capable of distinguishing real advances from the sometimes-breathless hype of the popular press. In short, you will be able to share the excitement as the scientific community addresses perhaps the greatest intellectual challenge of all – the challenge that Socrates described more than 2000 years ago as “to know thyself.”

**Can 21st-century molecular biology answer age-old questions about the human experience? Can studying proteins and DNA help us understand how we make our choices in sex and love? How we communicate? Where our emotions come from? Or why we age and die?**

In this fascinating journey into the biology of cells, Peter Schattner explains how proteins and DNA affect our lives. Based on the latest scientific discoveries, *Sex, Love and DNA* explores the amazing world of molecular biology through stories of people who don't feel pain because of rare genetic variants, children whose DNA enables them to perform unusual feats of strength, and people who can't speak or read simply because they lack certain proteins. Written in language that anyone can understand, *Sex, Love and DNA* will show you how science is revolutionizing our understanding of what it means to be human.



Peter Schattner is a scientist, educator and writer with 30 years experience in molecular biology, biomedical instrumentation and physics. He is the author of numerous research articles and scientific reviews as well as the textbook *Genomes, Browsers and Databases*. *Sex, Love and DNA* is his first book for nonscientists.

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