

ESSAYS

READING DNA

By Robert E. Pollack

Every now and then an event within one or another science rises above its professional horizon, to light or trouble the ways of people far from science. The most obvious example in our lifetimes is the discovery in 1938 that the nuclei of certain very heavy elements will break apart in a manner that causes new nuclei to break apart in turn. The discovery of nuclear fission took about a decade to move from first experiments to the theaters of war, but when the bomb exploded over Los Alamos and then Hiroshima, the world changed forever.

Jim Watson and Francis Crick's imaginative unraveling of the structure of DNA in 1953 has had a similar period of gestation, even though no military security cloaked it at any time. From its discovery until the early 1970s, the structure of DNA, a long, skinny assembly of atoms identical in form and function to the letters of a book, belonged to science and medicine.

Recently, three technological advances have moved the reading of DNA out of the lab and into all our lives: the capacity to cut a molecule of DNA into specific pieces and to link pieces to each other at specific places; the capacity to uncover the information in a piece of DNA; and the capacity to synthesize short stretches of DNA by machine.

With these skills, anyone with enough time and money can begin to read, edit, and rewrite the genetic script for the construction of an organism of any species, including our own. We have just begun to acquire editorial power over inheritance. Time and random mutation are no longer the only sources of alternative texts; we can begin to rewrite the book of instructions for the organization and assembly of a living thing, and see our homemade variant off as a player in evolution's endless game.

Striking as that power may be, it remains the case to this day that few people who are not scientists know much about DNA. A clear sense of how living things evolve and grow is shockingly rare among educated people, and almost totally missing from the lives of most children, adolescents, and college students. There are many reasons for this cultural lag, but chief among them is a simple fact: the text is chemical, and not many people of any profession—outside of molecular biology and its parent sciences of physics and chemistry—think about atoms or molecules in any context, let alone as the medium in which a text is written.

Those of us who do think about DNA, in particular about the DNA of a human being, are humbled by the size of the text. The DNA text of any one person is about three billion letters long. Of those three billion letters, perhaps a million, or about one letter in 3,000, have been read out at the cost of a few dollars per letter. We have taken the DNA for analysis from healthy people, and also from a good number of people who suffer from one or another inherited disease. But for all we have done so far, only a trace of the DNA text has been deciphered.

Soon, though, the structure of DNA will emerge as a necessary part of any educated person's vocabulary and imagery. Plans are underway—political organizations are being mobilized and funds are being allocated—to read and catalog the entire sequence of a human genome, the full text of a person's DNA.

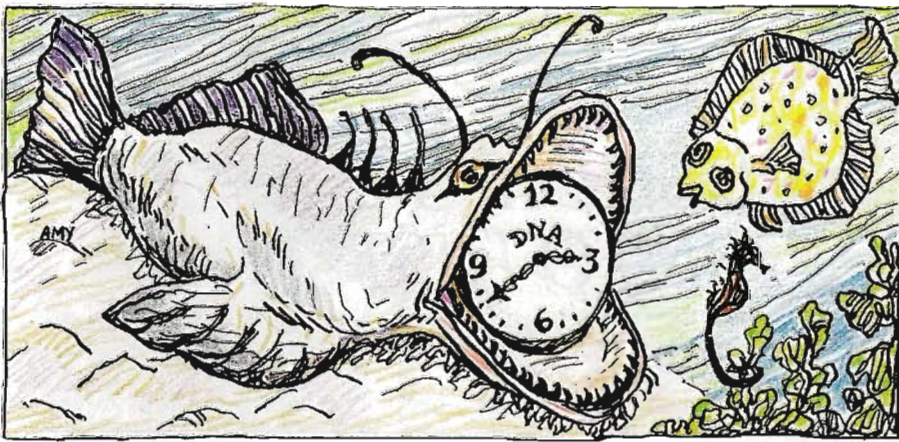
This is an awesome project. Once DNAs are read like books, whole new worlds of discourse will open up as we apply our various disciplines to nature's text. Will there be a "canon" of DNA texts? Are there portions of the text we should not read? Will DNA texts allow themselves to be analyzed for their meaning, or will meaning be evanescent and in the mind of the reader, as certain literary theorists today would predict?

The notion of DNA as text makes it possible to imagine natural selection as an author in "deep time," editing to change text at the rate of perhaps a letter every few centuries to produce the instruction books for all living things. Just as analysis of the fossils gives us the historical record of mountains and oceans as they formed and reformed over billions of years, so analysis of DNA texts will provide new information about events in biological



The Gestation of DNA

ILLUSTRATIONS: AMY POLLACK



"Deep Time"

evolution that shared the same deep times.

Natural selection chooses among species, not among individual members of a species. Despite that each species has an individuality, a life and a death, it is hard for us to see humankind as making up an individual in evolutionary terms, but it is the way things really are. It is certainly not a thought that would come naturally to a person stuck in a posture of racial superiority. Yet whether or not any of us accept a shared fate with humans of all other races and all living things of whatever size and shape, that is the way nature works, and that is how we got here.

Just as important, that is how we will leave the scene. Unless we come to terms with ourselves as a single species, we will not be able to deal intelligently with the threats posed by nuclear weapons and massive degradation of our planet's atmosphere. Microbial competitors, parasites, and invaders represent a real biological threat to all of us. The AIDS virus may be new, but the notion of a bacterial or viral pandemic is much older than the Black Plague.

As the chance to rethink our origins and our natures becomes a necessity, it will be necessary as well to change the way young people are educated. Like any other set of books long hidden and newly discovered, the DNA text of our species—the human genome—will not be read too quickly or too easily. It will first have to be uncovered, deciphered, cataloged in some order for future reference, translated, and cross-referenced to other texts. It seems to me that all of these activities are still what one might call

science, but that following hard upon them something new will occur: the human DNA text, in all its variations, will be subjected to literary analysis.

The text will reflect the specific history of life on this planet. We can be certain that the text will be full of references to the past, that the DNA of any individual will carry sequences in common with most or even all living creatures. We have already found examples of double meaning in the text: one sequence encoding two different proteins and therefore two different reading frames. We can expect to find more double meanings, puns, anagrams, and other oddities.

Each species alive today carries traces of DNA text from its ancestral species: the comparison of texts of DNA from different species will provide new details of the idiosyncratic history of the coming and going of species on this planet. Without an understanding of DNA, there can be no hope of understanding evolution. And without understanding evolution, we are condemned to continue to abuse the lives we share this planet with, at our most profound risk. The species alive today are survivors in a selection that has eliminated many alternative forms of life. As the DNA of many species is read we will learn more about the design of a successful strategy for survival.

Robert Pollack '61C is dean of the College and professor of biological sciences. "Reading DNA" excerpted from Dean Pollack's remarks at the dedication of the Cold Spring Harbor DNA Learning Center, an educational program helping elementary through graduate students understand the scientific process.

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