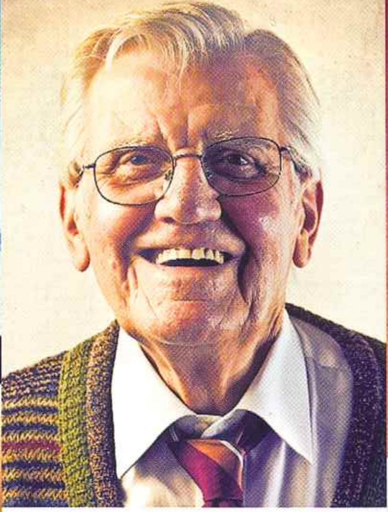
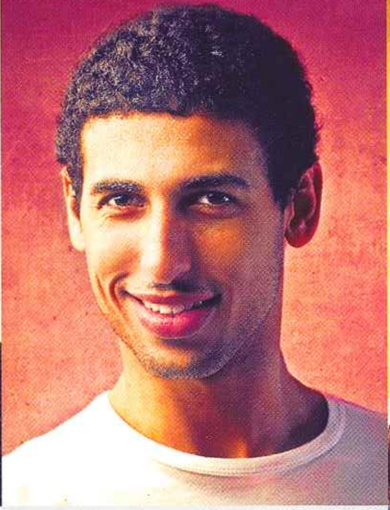
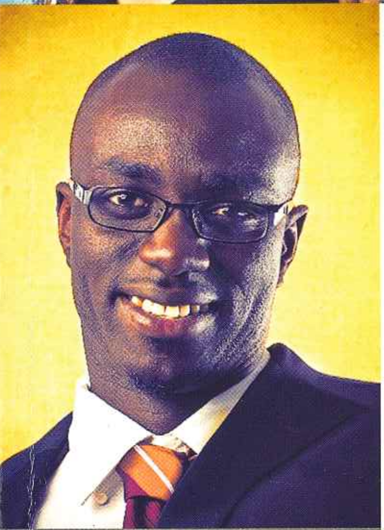




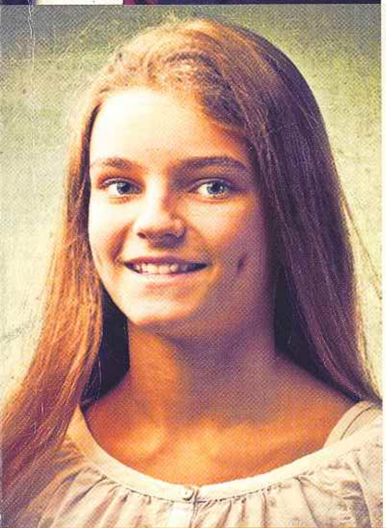


TIME

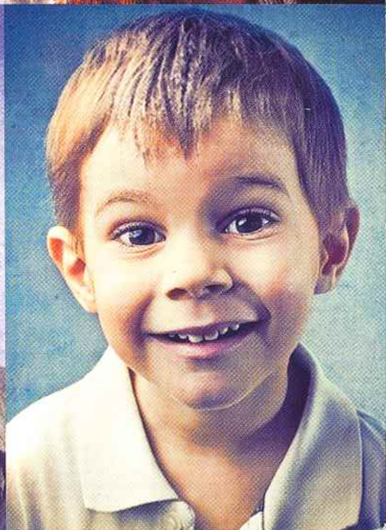
HOW DNA SHAPES YOUR LIFE

The New Genetic Discoveries
Health · Aging · Personality

BY ALICE PARK AND *TIME* CONTRIBUTORS





DISPLAY UNTIL 12/19/14
$13.99US $16.99CAN
TIME INC. SPECIALS

CONTENTS

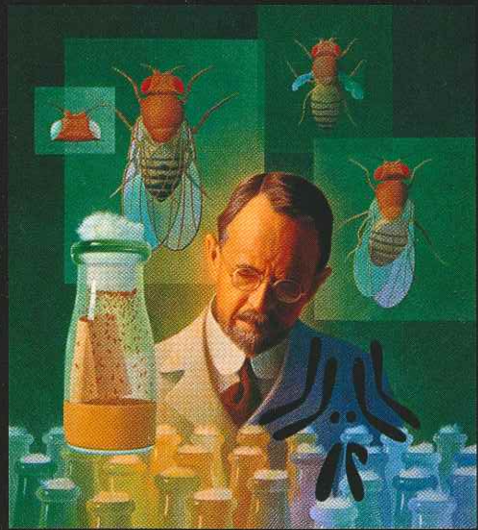
Portions of this book were previously published in TIME magazine and on Time.com.

THE LIGHT FANTASTIC *Scientists use fluorescent dye, ultraviolet light and electric current to separate DNA fragments suspended in gel.*

A Brief History of Genetics

Major moments on the way to unraveling the mysteries of DNA

by EMILY EGGLESTON



1865

Holy moment

A scientist-monk dabbed pollen on some plants and changed our understanding of life itself. In a monastery in what is now the Czech Republic, **GREGOR MENDEL** noted that pea plants inherited parents' traits—say, purple flowers or short stems—in predictable patterns, and that some traits were more common than others. After eight years and thousands of seedlings, Mendel published his theory of dominant and recessive inheritance, countering the "wisdom" of the day that offspring are a blended and diluted version of parents. Mendel's tweak: traits don't disappear; they're masked or displayed depending on the mix of genetic material parents contribute. His work didn't catch on until American scientist Rollins Emerson rediscovered his principles using corn plants in 1900. Likewise, the term "genetics" wasn't coined until the turn of the century, but Mendel and his peas planted its seed.

1869

DNA debuts

If Mendel is the Father of Genetics, **FRIEDRICH MIESCHER** is the Daddy of DNA. In his first laboratory job after medical school, the 25-year-old Swiss doctor was studying lymph gland cells in Germany. But when the cells proved difficult to procure directly from the gland, he turned to a secondary source: pus from surgical bandages. As Miescher categorized the proteins present in the pus, he also distilled an acidic material he found inside the various cells' nuclei. Investigating further, he found that every cell contained it and speculated that it might carry hereditary information. (He ultimately rejected that idea.) The material came to be known as deoxyribonucleic acid, or DNA.

1910

The original gender gap

At Columbia University, geneticist **THOMAS HUNT MORGAN** peered through a magnifying glass at a fruit fly, and what stared back intrigued him. Instead of the beady red eyes he expected to see, this fly's were white. Morgan crossed the white-eyed male with a red-eyed female and was intrigued again by the result: all of the male offspring were white-eyed too. His colleagues in the scientific community assumed that chromosomes were sex-specific (XX for women, XY for men, as it is represented today), and that is what explained inheritance patterns. Morgan's fruit fly experiments confirmed they were right.

1928

Transformers

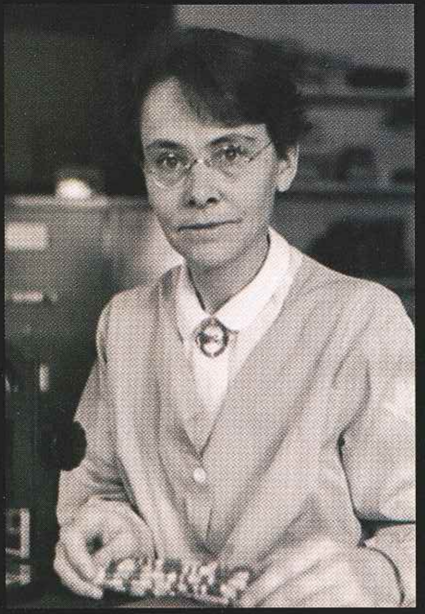
A deadly flu ravaged the globe in 1918. It afflicted one third of the population, killing more than 50 million people in all, and spurred researchers to figure out how to make sure another pandemic never occurred again. Many of them searched for vaccines, and one, British microbiologist **FREDRICK GRIFFITH**, found that injecting dead pneumonia-causing bacteria into mice protected them from disease. Griffith's contribution is not the vaccine he created, though, but what he saw along the way. The bacteria he used has several strains; some cause disease, some don't. When he mixed dead bacteria with non-disease-causing bacteria, the harmless version turned harmful. Griffith deduced that the live bacteria changed themselves by slotting in a component of the dead bacteria. He'd discovered genetic transformation, which underpins much of the genetic engineering being done today.

CONTINUED

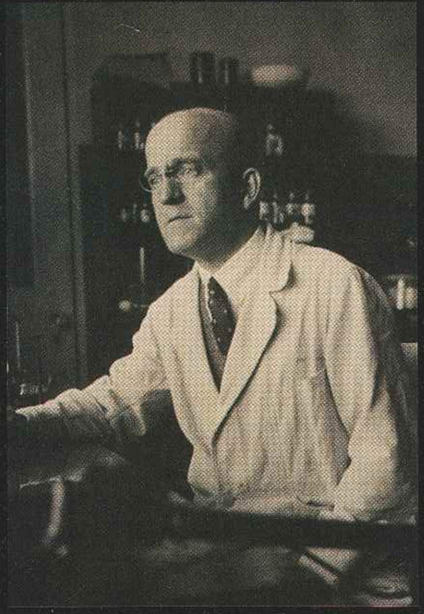
1931

Jumping genes

BARBARA MCCLINTOCK was a two-time pioneer, forging a new branch of genetics and carving out a space in the field for women by doing so. Her work with speckled corn kernels developed a new understanding of genes. Scientists had been using the word "gene" since the turn of the century to describe a unit of hereditary material, but they didn't actually know how a gene looked or functioned until McClintock and others shined a light. Genes, McClintock found, weren't locked in place but rather changed locations, and as a result conferred different effects. (Today those relocating genes are known as transposons.) To do her research, McClintock, who would be awarded the Nobel Prize in Medicine in 1983, meshed a knowledge of genetics with what she knew about cytology, the study of the structure and function of cells. The result was its own kind of genetic hybrid: the new field of cytogenetics.



1944



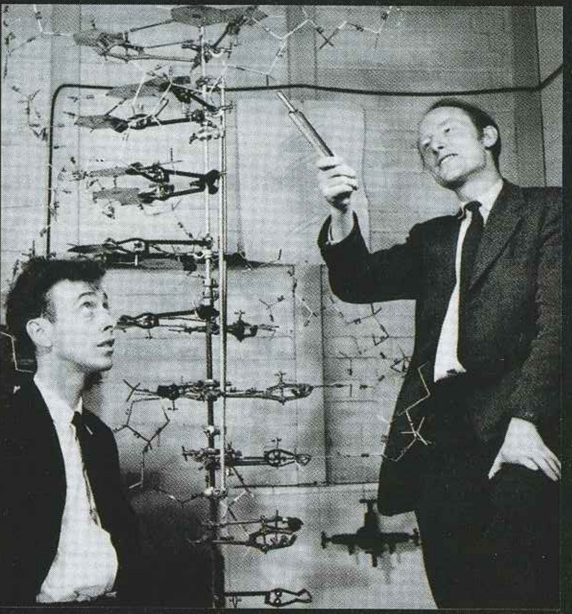
Getting the message out

Most scientists of the day believed an organism's genetic material was contained in its proteins. A team in New York City led by **OSWALD AVERY** set everyone straight. Working off Griffith's genetic-transformation experiments, Avery set out to determine exactly which part of the injected dead bacteria activated the new host bacteria. He re-created Griffith's work with one additional variable: in each round of his experiment, he destroyed one component of the dead bacteria before inserting it, then checked to see if the live bacteria still went viral. Through a process of elimination, Avery concluded that DNA was the carrier of genetic material. But much of the research community viewed Avery's findings with skepticism until 1952, when a second team affirmed that proteins were not the hereditary hardware.

1953

All wound up

When it comes down to it, all **JAMES WATSON** and **FRANCIS CRICK** did was discover a cool shape. Okay, they deserve more credit than that. The problem was this: though scientists knew the basic structural pieces of DNA—molecules known as nucleotides (specificially four of them: adenine, thymine, guanine and cytosine)—and how they interacted, no one had been able to conceive of a physical model to accommodate those chemical relationships. The eureka moment came after viewing an x-ray image of DNA captured by a colleague, **ROSALIND FRANKLIN**. The three-dimensional model Watson and Crick built after they saw Photo 51 looked like a spiraling ladder. The ladder finally gave a shape to the elusive DNA. It is known, of course, as the double helix.



1966

CONTINUED

Learning our ABCs

With the double helix solved, it was time to unravel the genetic instructions coiled up inside. The long string of molecules making up a strand of DNA appeared to geneticists like a million-page book with no spaces between words in a language they couldn't read and written with letters they'd never seen. An American scientist working for the National Institutes of Health, **MARSHALL NIRENBERG**, deciphered the first letter in 1961 and, by 1966, the entire alphabet. Those "letters" are, in fact, groups of molecules, known as nucleotides, that generate life's basic building blocks. A year later, Nirenberg reflected on the implications of his genetic Rosetta Stone in *Science*: "… this knowledge will greatly influence man's future, for man then will have the power to shape his own biological destiny. Such power can be used wisely or unwisely, for the betterment or detriment of mankind." Self-aggrandizing, yes, but he wasn't far off.

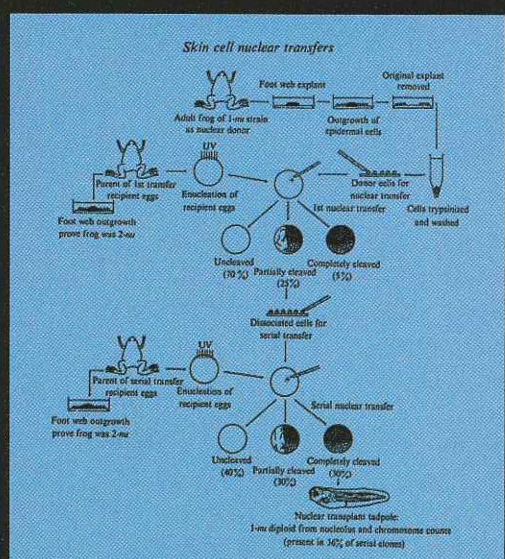
1973

Tailor-made

Almost as soon as Nirenberg described the information contained in DNA, science was asking the next question: How do we manipulate that information? Stanford biochemist **STANLEY COHEN** had the answer. He cut two pieces of DNA in half and then chemically sewed the pieces of the different strands together. Cohen had formed a novel string of genetic information. His cut-and-paste technology—recombination—was the first step toward reengineering an organism's DNA.

1975

A demonstration of differentiation

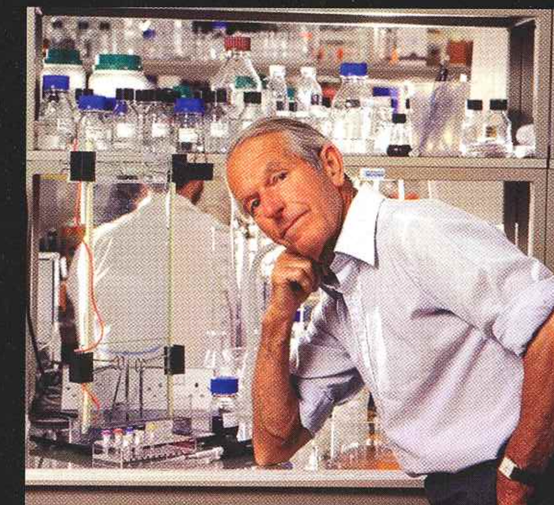


Everything you ever wanted to know about a frog—or any living thing, for that matter—you can learn from any of its cells. That was the lesson taught by molecular biologists in Cambridge, England. They took the DNA from a frog's skin cell and placed it in an embryo to see what would develop. The popular guess was skin. The actual result was an entire frog, the donor's clone, to be exact. DNA instructs each cell of an organism to perform a specific function. Before the frog experiment, scientists thought a cell might then ditch the DNA it didn't use, leaving it capable of only one function. Turns out every cell contains an organism's entire genetic manual—its genome—and deploys whichever part the body cues.

1977

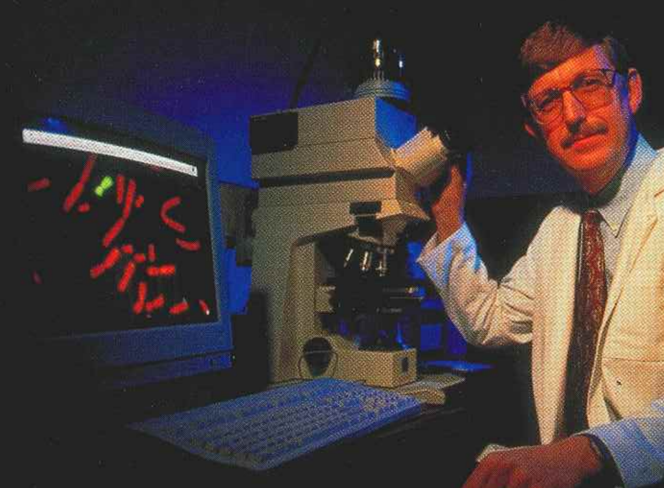
Reading the manual

Nirenberg deciphered the genetic alphabet, but British biochemist **FREDRICK SANGER** helped geneticists read with it. DNA's four nucleotides repeat millions, even billions, of times along a genome, and it is their order that gives an organism its particular genetic makeup. Only by reading that order, though, can we group the nucleotides into genes, and only then can we begin to see how genes control that makeup. Bodies constantly generate new cells, and each gets a copy of the genome. Sanger crafted a method to document nucleotide order by imitating the body's process of DNA replication, a technique called sequencing, and published the first full genome sequence, of a virus's relatively short genome. Three years later, he won the Nobel Prize in Chemistry. (It was his second Nobel, making him one of only four multiple winners.)



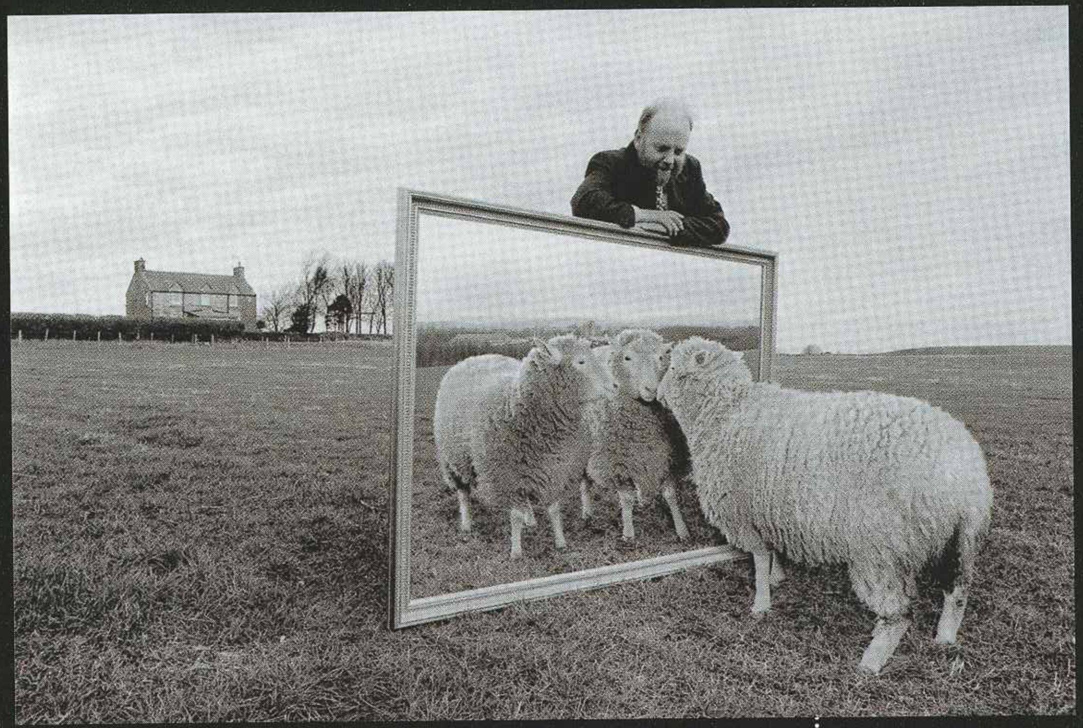
1987

CONTINUED



The search is on

Genes control all, but practically speaking, it is the genes that control disease that matter most to the scientific community. One of the most successful hunters of those kinds of genes is American physician **FRANCIS COLLINS**. Collins isolated the gene responsible for cystic fibrosis in 1987 and the ones for Duchenne muscular dystrophy and Huntington's disease a year later. Since then, thousands of genetic mutations have been located, with almost 100 marked as potentially related to cancer alone.



1988

Order in the court

On February 6, a 27-year-old rape victim in Orlando, Fla., watched a jury convict her assailant after being convinced of his guilt by DNA evidence. (DNA from his blood matched DNA in semen found at the crime scene.) It was the first conviction in a case that admitted DNA as evidence. Within 10 years, all 50 states had established DNA banks to hold samples of known criminals' genetic material.

1996

Secondhand wool

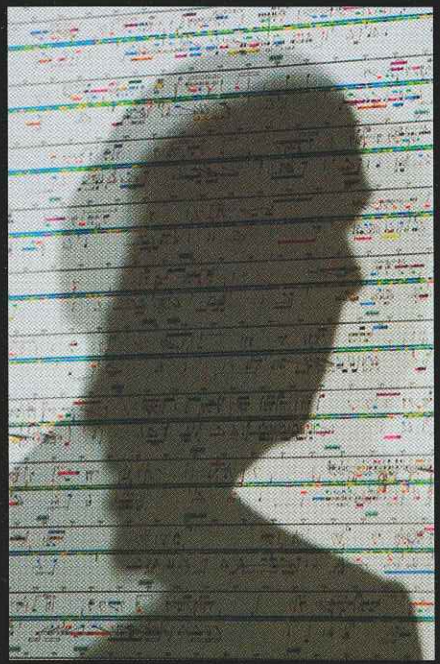
Plato, Pelé, Rihanna … you have to do something special to be on a first-name basis with the rest of the world—like being the first cloned mammal. Scientists had made exact genetic duplications of organisms before, but Dolly's replication was a big step forward. Humans are mammals too, after all, so cloning a sheep opened up intriguing possibilities. Then again, Dolly's death at the age of 6, from a large tumor on her lung, raised questions about the long-term health of clones. Short-term viability, however, had already been assured; by the time Dolly died, scientists had cloned six other mammals: a cow, pig, goat, rabbit, cat and mouse.

1996

Billion-dollar solution

The European corn borer isn't nicknamed the Billion Dollar Bug for nothing. The relentless and extensive damage it does to crops made it one of agriculture's worst pests. But it is no longer the scourge it once was, not since a new corn seed hit the market. Geneticists reengineered the plant's DNA by inserting a gene that enabled the corn to turn a soil bacterium into a toxin that warded off the borers. Farmers were immediate fans of the seed and of subsequent genetically modified crops because they are hardier and more cost-efficient to maintain. Science-fiction catastrophists remain a little less optimistic.

2003



Presenting … the human genome

It took researchers in 18 countries and about 200 laboratories in the U.S. alone to get there, but after 13 years and 3.2 billion nucleotides, the world was introduced to a complete reading of the human genome. Back in 1992, two years into the Human Genome Project, J. Craig Venter, a scientist at the National Institutes of Health, broke from the coordinated global effort to work on the task in a privately funded lab. Venter's competitive effort pushed the worldwide project into high gear, and the race was on. In the end, though, the parallel efforts published their results simultaneously. A tie for the scientists was a win for the world—the project finished ahead of schedule and under budget.

2010

Outside in

The main purpose of human genome sequencing was to better understand what our DNA can do, and what we can do to manipulate it. But even as geneticists see that DNA affects all outcomes of human life, they have begun to realize that other factors of daily living affect DNA as well. Epigenetics is the study of how genes are influenced by outside forces, like the environment or lifestyle or medicine. Take, for example, cancer. Cancer cells reproduce uncontrollably because genes that regulate their production have been turned off. Epigenetic researchers have created an external intervention, a medication, that turns the genes back on, effectively halting tumor growth.