Publisher's Note

Contemporary Biographies in Chemistry is a collection of thirty-one biographical sketches of "living leaders" in the fields of physics. All of these articles come from the pages of *Current Biography*, the monthly magazine renowned for its unfailing accuracy, insightful selection, and the wide scope of influence of its subjects. These up-to-date profiles draw from a variety of sources and are an invaluable resource for researchers, teachers, students, and librarians. Students will gain a better understanding of the educational development and career pathways—the rigors and rewards of a life in science—of the contemporary scientist to better prepare themselves for a scientific career.

The geographical scope of *Contemporary Biographies in Chemistry* is broad; selections span the Eastern and Western Hemispheres, covering numerous major geographical and cultural regions. While most of the figures profiled are practicing scientists in their respective fields, the selection also includes scientifically trained government officials, institutional directors, and other policy leaders who are helping to shape the future of science by setting agendas and advancing research. Scientific fields covered range from biochemistry to genetics, to pharmacology and oncology, and from chemical engineering to molecular biology.

Articles in *Contemporary Biographies in Chemistry* range in length from roughly 1,000 to 4,000 words and follow a standard format. All articles begin with ready-reference listings that include birth details and concise identifications. The articles then generally divide into several parts, including the Early Life and Education section, which provides facts about the scientists' early lives and the environments in which they were reared, as well as their educational background; and Life's Work, a core section that provides straightforward accounts of the periods in which the profiled subjects made their most significant contributions to science. Often, a final section, Significance, provides an overview of the scientists' places in history and their contemporary

importance. Essays are supplemented by bibliographies, which provide starting points for further research.

As with other Salem Press biographical reference works, these articles combine breadth of coverage with a format that offers users quick access to the particular information needed. For convenience of reference, articles are arranged alphabetically by scientists' names, and an appendix lists scientists' names by their country of origin. In addition, a general bibliography offers a comprehensive list of works for students seeking out more information on a particular scientist or subject, while a separate bibliography of selected works highlights the significant published works of the scientists profiled. An appendix consisting of ten historical biographies of "Great Chemists," culled from the Salem Press *Great Lives* series, introduces readers to scientists of historical significance integral to the genesis of chemistry and whose work and research revolutionized science.

The editors of Salem Press wish to extend their appreciation to all those involved in the development and production of this work; without their expert contribution, projects of this nature would not be possible. A full list of contributors appears at the beginning of this volume.

Barton, Jacqueline K.

American chemist

Born: May 7, 1952; New York, New York

"Lovely . . . with beautiful shape and symmetry." That is how chemist Jacqueline K. Barton described DNA (deoxyribonucleic acid) nearly twenty years ago during an interview with Stuart Gannes and Julianne Slovak for *Fortune* (October 13, 1986). A half-dozen years before, Barton had begun conducting experiments with DNA, the molecule that is basic to nearly all forms of life; orchestrates the activities of living cells; contains the genetic instructions for growth, development, and reproduction; and is so long that it might be considered "the biological equivalent of a colossal run-on sentence," as Gannes put it. Unlike most DNA researchers, Barton is neither a biologist nor a biochemist; rather, she is a specialist in bioinorganic chemistry, the study of inorganic compounds or ions (those that do not contain carbon-hydrogen bonds) in living organisms. In her research, she has treated the DNA molecule "as if it were an inorganic crystal, such as a piece of a rock or a semiconductor in a cell phone," thus introducing "a radically different way to think about DNA," as K. C. Cole wrote for the *Los Angeles Times* (December 29, 1997). By her early thirties, Barton had already made discoveries deemed so important that, in 1985, she became the first woman to win the National Science Foundation's Alan T. Waterman Award, the federal government's highest honor for scientists thirty-five years old or younger. Those discoveries were products of her pioneering creation and use of chemical "tools," made with metallic compounds, to recognize and modify specific sites on the DNA molecule. Then and in the years since, she has illuminated aspects of DNA's structure and some of the ways in which the molecule functions, including its conducting of electricity (which previously most scientists in her field had dismissed as impossible) and abilities to maintain and repair itself. According to a press release on the website of the California Institute of Technology (Caltech) announcing her

election to the National Academy of Sciences (May 1, 2002), Barton's work "provides a completely new approach to the study of DNA structure and dynamics and may be critical to understanding the chemical consequences of radical damage to DNA within the cell." As the National Science Foundation noted on its website, her findings have "important implications for drug design and for the theory of gene expression." "Perhaps because I'm a woman and now getting some attention I'm a role model," Barton told Steven Waldman for the States News Service (May 15, 1985) after receiving the Waterman Award. "That sort of thing makes me a little uncomfortable." However, she added, "young women need to see that women are doing science and doing it well." Barton taught and worked at Columbia University in New York City from 1983 until 1989, when she joined the faculty of Caltech in Pasadena. There, she holds the title of Arthur and Marian Hanisch Memorial Professor of Chemistry. Barton has published as author or coauthor more than 250 scientific papers and book chapters. Her many honors include seven awards from the American Chemical Society, election to the American Academy of Arts and Sciences and the National Academy of Sciences, and a 1991 MacArthur Foundation Fellowship, popularly known as the "genius grant."

Early Life and Education

Jacqueline K. Barton was born on May 7, 1952, in New York City. She attended a private high school, the Riverdale Girls School (now part of the co-educational Riverdale Country School), in the Bronx, at a time when, as she told Natalie Angier for the *New York Times* (March 2, 2004), "young girls didn't take chemistry"; indeed, her school did not offer a course in that subject. She enrolled in a chemistry class for the first time as a student at Barnard College (which was associated with and later became a division of Columbia University) in New York City, which she entered in 1970. Barnard was then a women's school, and as an undergraduate Barton "learned that there wasn't anything strange about a woman going into science," as she told Steven Waldman. She majored in chemistry and graduated with a bachelor's degree summa cum laude in 1974.

Barton next began graduate studies in physical chemistry at Columbia; it was only then that she noticed the prevalence of men in her field. But increasing numbers of women were becoming scientists, and she encountered little discrimination; in her experience, she told Waldman, scientists' work "generally speaks for itself." She was a National Science Foundation predoctoral fellow from 1975 to 1978. Barton chose as her PhD adviser the bioinorganic chemist Stephen J. Lippard, after he aroused her curiosity about a substance in which he himself had grown interested—a compound of platinum called cis-diamminedichloroplatinum, also known as cis-platinum or cisplatin, which had proven to be highly effective in treating certain types of cancers. Barton struck Lippard as "clearly a very bright student, quite strong mathematically. Pure algebra, quantum mechanics—she was really good at that," as he told Will Hively for *Discover* (October 1994). Lippard suggested that she try to determine the structure of platinum blue, the compound formed by cis-platinum and uracil (the latter of which is very similar to thymine, one of the basic components of DNA)—"no easy task," as Hively wrote: "First she had to produce a crystal large enough to study; then she had to figure out the location of atoms in the crystal by analyzing the patterns produced by X-rays shot through the crystal." In what Lippard described to Hively as "a major breakthrough," Barton succeeded. The platinum-blue molecule, she determined, contained on its periphery several exposed platinum atoms that could potentially bond with other atoms—including those in components of DNA. Depending on the location, their bonding with the DNA molecule might hinder the further reproduction of cancer cells. Thus, as Hively wrote, "Barton's discovery opened up a whole new field of anticancer compounds." "Crystalline Platinum Blue: Its Molecular Structure, Chemical Reactivity, and Possible Relevance to the Mode of Action of Antitumor Platinum Drugs," by Barton and Lippard, was published in the *Annals of the New York Academy of Sciences* in 1978. Barton earned a PhD in inorganic chemistry in 1978. During the next year, supported by postdoctoral fellowships, she worked with the biophysicist and biochemist Robert G. Shulman at Bell Laboratories and then, in 1980, at Yale University in

New Haven, Connecticut. From 1980 to 1982 she taught chemistry at Hunter College, a division of the City University of New York. She joined the faculty of Columbia in 1983 and remained there for the next six years, during the last three with the title professor of chemistry.

Life's Work

When Gary Taubes, writing for *Science Watch* (January/February 1997), asked Barton how she would describe the "overriding theme" of her research, she responded, "My interest is in using chemistry to ask molecular questions about biological systems—to explore on a chemical level the relationship of structure to function." The goal of Barton's work since the 1980s has been to gain a better understanding of DNA, a nucleic acid whose structure was discovered in 1953 to be a double helix. In humans, DNA is present in twenty-three pairs of chromosomes (each parent having provided one set of twenty-three) located within the nucleus of almost every cell. (Among the few exceptions are mature red blood cells, which do not have nuclei, and reproductive cells, or gametes—sperm and eggs—each of which has only one set of twenty-three, not two.) Each chromosome contains one DNA molecule. Infinitesimally narrow but about six feet long, the molecule is extremely tightly coiled; if stretched to its full length, it would resemble a ladder that has been twisted along its midline millions of times. Each side of the ladder (also referred to as a strand or a backbone) looks like a necklace strung with millions of linked beads, with each bead composed of a phosphate molecule bonded to a sugar molecule (the sugar being deoxyribose). The rungs, or steps, of the ladder are all of equal length, and the outer ends of each rung are connected to one of the sugar-phosphate "beads" that lie along each strand. The ladder has two types of rungs, with each type made up of a pair of molecules called bases; there are four bases, each of which is a different arrangement of carbon, hydrogen, oxygen, and nitrogen atoms. One type of rung, the A-T pair, consists of the base adenine (A) weakly linked by two hydrogen bonds to the base thymine (T); the other type, the C-G pair, consists of the base cytosine (C) weakly linked by three hydrogen bonds to the base guanine (G). In normal DNA, A connects only to T, and C connects only to G. Thus, one side

of the ladder is the complement of the other: if a sequence of nine bases on one side of the ladder is CCTAGTTGG, the corresponding sequence of nine bases on the other side of the ladder must be GGATCAACC. The chemical "direction" of one side of the ladder is the opposite of the other's; the two strands are said to be "antiparallel," and each plays a different role in the cell. Among the findings of the fed-

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eral government's ongoing Human Genome Project is that the number of base pairs (the "rungs") in a DNA molecule ranges from nearly 47 million in chromosome 21 to more than 245 million in chromosome 1. A base plus its connected sugar and phosphate molecules is called a nucleotide. A gene is a connected series of nucleotides; every human's approximately 20,000 to 30,000 genes (the precise number has not yet been determined) range in length from fewer than one thousand nucleotides to several million; the average number is about three thousand. Genes are described in terms of codons, each codon being a sequence of three of the four bases (TTT, TCC, CTA, CTG, etc.); the total number of codons is sixty-four (the four bases combined three at a time; $4^3 = 64$). Every codon contains information connected with the creation of one of twenty standard amino acids (aspargine, histidine, leucine, tryptophan, etc.), the components of proteins, from which muscle, nerves, blood vessels, bone, and everything else in the body is made. (Since there are only twenty, each amino acid is associated with more than one codon.) Each gene is located in a specific position on a particular chromosome. Only about 2 percent of the nucleotide sequences of human DNA are genes; the functions of the rest—known variously as junk DNA or noncoding DNA—are only beginning to be elucidated. Although the media and scientists, too, refer to "the" human genome, "a" human genome would be more accurate, because no two individuals have precisely the same DNA; according to the website Genome.gov, a comparison of the DNA of individuals will show variations of one nucleotide per thousand nucleotides, on average. (It

Henry Cavendish

French-born English scientist

Cavendish, a reclusive character, made significant advances in the chemistry of gases and contributed to the study of electrical phenomena.

Areas of Achievement: Chemistry, physics

Born: October 10, 1731; Nice, France

Died: February 24, 1810; London, England

Early Life

Little is known in detail about the personal life of Henry Cavendish. He was born into a leading aristocratic British family. His father, Lord Charles Cavendish, was the third son of the duke of Devonshire, while his mother, Lady Anne Grey, was the daughter of the duke of Kent. His mother's death when he was two years old left him totally in his father's care. He entered Dr. Newcombe's Academy in Hackney in 1742 and matriculated at St. Peter's College, Cambridge, in 1749, leaving in 1753 without taking his degree. Most biographers have speculated that he refused the religious tests required for a degree, but no evidence exists concerning his religious convictions at any time in his life.

After leaving Cambridge, he resided with his father in London. Lord Charles Cavendish was a longtime member of the Royal Society and an avid investigator of meteorological and electrical questions, having received the society's Copley Medal for perfecting a registering thermometer. His father sponsored his election to the Royal Society in 1760; living in an all-male environment permeated with scientific conversation may very well have shaped both Cavendish's lifelong fascination with science and his strange social behavior.

Throughout his life, Cavendish was reclusive, shunning human society. He was restricted by his father to an extremely small allowance, forcing him to become very close with money, often attending Royal Society dinners with only the 5 shillings necessary to gain admission. Following his father's death in 1783, he came into a large family inheritance. While very wealthy, he remained parsimonious in his personal expenditures and oddly indifferent to other uses of money, giving generously to charity but always checking the list of donors and giving precisely the amount of the largest donation. Abhorring any meeting with women—he even left notes for housemaids to avoid personal contact—Cavendish remained an eccentric and elusive person. Only in the Royal Society, where he attended regularly and participated fully, did he have any public life. He was responsible for a detailed description and analysis of the society's meteorological instruments in 1776 and served on a committee investigating lightning protection for the Purfleet powder magazine, using his own electrical research to recommend pointed rather than blunt lightning rods. Even at the Royal Society, however, he would flee if approached by a stranger, and he was often seen outside the meeting room, waiting for the moment when he could slip in unnoticed. To the end of his life he was so totally devoted to science that everything else was secondary.

Only one portrait of Cavendish exists, a watercolor sketch by Sir John Barrow done surreptitiously at a dinner meeting of the Royal Society. It shows a somewhat tall, lanky middle-aged man of a rather sharp and thrusting appearance, dressed in a greatcoat and three-cornered hat stylish in the 1750s. Apparently the dress was his usual, as he was noted for never changing the style of his clothing and purchased only one set of clothing at a time, following a precise schedule as the old garments were worn out.

Life's Work

In his lifetime, Henry Cavendish was known primarily for his research in chemistry and electricity, work reflected in a remarkably small number of papers in the *Philosophical Transactions of the Royal Society*. His first public work was in 1776, a series of papers on the chemistry of "factitious airs," or gases. Chemistry at the time was dominated by