

SUPER WOMEN

Six Scientists
Who Changed
the World

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INTRODUCTION

IMAGINE being a highly trained astronomer who's forbidden to look through a state-of-the-art telescope, or an accomplished underwater cartographer who's not allowed to sail on research ships. Imagine graduating with honors in chemistry but being told you're "too distracting" to work in the research laboratory. All because you happen to be a woman.

Pioneering scientists Eleanor Margaret Burbidge, Marie Tharp, and Gertrude Elion experienced such thunderbolts of discrimination more than half a century ago. Florence Hawley Ellis, who forged her career as an archaeologist in the inhospitable Southwest United States in the 1930s, was told point-blank that men would refuse to work for a female boss on her first organized dig. Mathematician Katherine Coleman Johnson and marine biologist Eugenie Clark faced double prejudice as women of color. Johnson, an African American, was initially relegated to a segregated office area when she began work as a "human computer" for what later became the National Aeronautics and Space Administration (NASA). Japanese American Clark faced interrogation by the FBI as a possible alien terrorist following World War II and was forced to forfeit a research expedition to the Philippines.

These six super women shared a passion for discovery and a love of science in spite of daunting obstacles. Again and again they were forced to leap over academic, societal, and professional barriers, and they did so with remarkable courage, energy, and endurance. What made these six scientists super women was not just their rigorous minds, quest for knowledge, and ability to learn from mistakes, it was also the way they tirelessly mentored and inspired confidence in the next generations of young women scientists. Their advice is perhaps best summed up by Nobel Prize Laureate Trudy Elion, who once said, "Do not let anyone discourage you."

While enormous strides continue to be made in the twenty-first century, women and individuals of color sometimes still encounter subtle discouragement and prejudice in the sciences. Much remains to be accomplished to ensure that collaborative scientific research includes the broadest spectrum of perspectives. "The future of our country increasingly depends on science and technology," writes Meg Urry, the Israel Munson Professor of Physics and Astronomy at Yale University and the Director of the Yale Center for Astronomy and Astrophysics. "We need all the best brains, regardless of gender."

CHAPTER ONE

Eugenie CLARK

The 13-ton whale shark swam straight for Eugenie “Genie” Clark and the three other scuba divers. Its open mouth was so enormous it could easily have swallowed all four of them at once. Suddenly, the city bus-size creature veered away. As it did it peered at Genie for a moment through one great dark eye rimmed with white. The shark’s benign glance inspired the 59-year-old scientist to do something few would have dared.

She decided to take the ride of her life.

She flippered closer. Ducking under the massive pectoral fin that projected like an aircraft wing, Genie trailed her fingers along the rough side of the whale shark. White dots as big as her hand adorned its thick, elephant-like hide. Quickly, she propelled herself upward to the shark’s back and grabbed the soft trailing edge of its dorsal fin.

The whale shark plunged with enormous, slow beats of its tail. Like a jockey, Genie pulled up her knees and sat astride the shark’s emery-board back. The biggest

known species of fish in the world picked up speed. Faster, faster.

Water pressed against Genie’s face. If she turned her head to try to spot her distant companions or the dive boat, she feared that her diving mask would rip away. Her hands began to cramp. Scraped skin on her inner legs stung. She adjusted position, lowered herself onto her belly, and slid past the rear dorsal fin to the immense tail. She hung on as she was whiplashed from side to side before being catapulted free.

Unharmed, she floated to the surface. Her scuba tank had come loose. She’d lost a flipper, and her mask dangled from her neck. No matter. Eagerly, Genie took one last look at the rare shark as it surfaced and then dove out of sight.

That afternoon in 1991 off the tip of Baja California was the most rewarding experience of her career.

Nicknamed the Shark Lady, Genie spent more than seven decades studying

“magnificent, misunderstood” sharks. Her innovative research debunked common myths about many of the 350 shark species that had been stereotyped as vicious deep-sea thugs or brainless eating machines. She also investigated a wide variety of other amazing sea creatures around the globe.

Genie’s love of the ocean and its creatures started when she was a young child. Fascination, curiosity, and courage never left her—even when she met with difficult obstacles pursuing her career as a female, mixed-race marine biologist and ichthyologist (fish expert) at a time when the field was dominated almost exclusively by white men.

Genie Clark was born May 4, 1922, in New York City. Her mother, Yumico Mitomi, was Japanese. Her American father, Charles Clark, died when she was a baby. To make ends meet, her mother often had to work long hours selling newspapers and other items in the lobby of a New York club.

When Genie was nine years old, her mother took her to the New York Aquarium that once stood at the southern tip of Manhattan. Spellbound, she leaned over a brass railing and brought her face as close as possible to an enormous tank filled with green water and mysterious, undulating creatures. “I pretended I was walking on the bottom of the sea,” she later wrote.

Every Saturday while her mother worked, Genie roamed the aquarium and studied the fish—from fast gliders to sluggish bottom creepers. On her birthday her mother splurged and bought Genie a 15-gallon

aquarium complete with aquatic plants and gravel to serve as a home for the girl’s growing collection of guppies, swordtails, and clown fish. Soon their three-room apartment turned into a menagerie that included salamanders, a horned toad, an alligator—even a black racer snake she named Rufus. From then on, every bit of Genie’s allowance went toward the purchase of more creatures and supplies and food for them.

The ocean had captivated Genie since she was a toddler. On family expeditions to the beach on Long Island in the summer, she went swimming with her mother, grandmother, and uncle. Her mother was a strong, graceful swimmer even in rough surf. (One of her swimming secrets: softened chewing gum stuffed inside ears prevented swimmer’s ear infections). The best swimmers, Genie soon realized, were the fish. How did they do it? She read every book she could find to discover their secrets.

Zoology, the study of animals, intrigued Genie throughout high school. How would she be able to afford college to pursue this interest? Luckily, she was accepted at tuition-free Hunter College, a women’s college that was part of the New York City college system. She finished her degree in 1942, just as the United States entered World War II after Japan’s attack on Pearl Harbor, Hawaii. This was an anxious time for Japanese-speaking American citizens, who were sometimes considered to be possible enemies.

Because of her Anglicized name and her background in science, Genie was able to find

CHAPTER THREE

Katherine Coleman Johnson

Of the millions of Americans who watched live television coverage of the dramatic liftoff of Project Mercury's *Freedom 7* at Cape Canaveral, Florida, at 9:30 EST on the morning of May 5, 1961, few may have been as anxious as Katherine Coleman Johnson. Her mathematical computations were about to help send American astronaut Alan B. Shepard Jr., into orbit around the Earth.

So much was riding on the mission's success.

The United States was in a neck and neck race for space with the Soviet Union (which included what is now called Russia and other nearby countries). Just three weeks earlier, Russian cosmonaut Yuri Gagarin had become the first man in space. Now the United States hoped to overtake the Russian space program's lead by sending its first manned spacecraft into orbit. Unlike Gagarin, Shepard would be able to maneuver the spacecraft himself. Would everything go as planned?

Nervously, 43-year-old Katherine

watched as boosters roared beneath the seven-story-high, 66,000-pound Redstone rocket. The ground shook. Slowly, *Freedom 7* rose into the sky.

Dozens of variables—everything from speed and atmosphere resistance to gravitational pull and time—had been used to calculate the launch, trajectory, orbit, and return flight of the spacecraft. Before the invention of reliable electronic computers, the accuracy and safety of space flight depended on people like Katherine and the rest of the Langley Field Research team, who crunched numbers with slide rules and mechanical calculators. (The word “computer” was first used to describe the person who did the math—not the machine.) The math equations of Katherine and her team of “computers” were checked and rechecked countless times. There could be no errors.

Undoubtedly, Katherine breathed a sigh of relief when *Freedom 7* reached the predicted altitude of 116 miles above Earth,