WOMEN IN SCIENCE

50 FEARLESS PIONEERS WHO CHANGED THE WORLD

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INTRODUCTION

Nothing says trouble like a woman in trousers. That was the attitude in the 1930s, anyway; when Barbara McClintock wore chinos at the University of Missouri, it was considered scandalous. Even worse, she was feisty, direct, incredibly smart and twice as sharp as most of her male colleagues. If you think these seem like good qualities for a scientist, you're right. But back then, these weren't necessarily considered good qualities in a woman.

Barbara made her mark on the field of genetics with her pioneering work mapping chromosomes. Yet while working at the University of Missouri, Barbara was seen as bold and unladylike. The faculty excluded her from meetings and gave her little support. When she found out that they would fire her if she got married and there was no possibility of promotion, she packed her bags. With no plan, except an unwillingness to compromise her worth, Barbara went to find her dream job. This decision would allow her to eventually make the discovery of jumping genes, winning her a Nobel Prize and forever changing how we view genetics.

Barbara McClintock's story is not unique. As long as humanity has asked questions about our world, men and women have looked to the stars, under rocks and through microscopes to find the answers. Both men and women have the same thirst for knowledge, but women have not always been given the same opportunities to explore the answers.

In the past, restrictions on women's access to education were not uncommon. Women were often not allowed to publish scientific papers. They were expected to grow up to become good wives and mothers while their husbands provided for them. Many people thought women were just not as smart as men. The women in this book had to fight these stereotypes to have the careers they wanted. They broke rules, published

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under pseudonyms and worked for the love of learning alone. When others doubted their abilities, they had to believe in themselves.

When women finally began gaining wider access to higher education, there was usually a catch. Often they would be given no space to work, no funding and no recognition. Not allowed to enter the university building, Lise Meitner did her radiochemistry experiments in a dank basement. Without funding for a lab, Marie Curie handled dangerous radioactive elements in a tiny, dusty shed. After making one of the most important discoveries in astronomy, Cecilia Payne-Gaposchkin worked for decades as a technical assistant. Creativity, persistence and a love of discovery were the greatest tools these women had.

Marie Curie is now a household name, but throughout history there have been many other great and important women in the fields of science, technology, engineering and mathematics. Many did not receive the recognition they deserved at the time and were forgotten. When thinking of physics, we should name not only Albert Einstein but also Emmy Noether. We should all know that it was Rosalind Franklin who discovered the double helix structure of DNA, not James Watson and Francis Crick. While admiring the advances in computer technology, let us remember not only Steve Jobs or Bill Gates, but also Grace Hopper.

Throughout history many women have risked everything in the name of science. This book tells the stories of some of these scientists, who in the face of 'No' said, 'Try and stop me.'

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ONE OF THE FIRST RECORDED WOMEN TO STUDY & TEACH MATHS.

HAS BECOME A SYMBOL FOR ENLIGHTENMENT AND FEMINISM.

AN EXPERT IN PHILOSOPHY, ASTRONOMY AND MATHEMATICS.

— 'IN SPEECH ARTICULATE AND LOGICAL, IN HER ACTIONS PRUDENT AND PUBLIC-SPIRITED ... —
THE CITY GAVE HER SUITABLE WELCOME AND ACCORDED HER SPECIAL RESPECT.' —THE *SUDA* LEXICON

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HYPATIA

ASTRONOMER, MATHEMATICIAN AND PHILOSOPHER

Hypatia was one of the earliest recorded female mathematicians. Her accomplishments in life inspired many, but her death turned her into a legend.

Hypatia was born between 350 and 370 CE in Alexandria, Egypt. Her father, Theon, was a famous scholar. He made sure that she was well educated and that she grew up with a deep respect for their Greek heritage and values.

Alexandria, known for its library, was a great place of learning – but it was also rife with religious tensions between pagans, Jews and Christians that could turn violent. This made it dangerous for Hypatia and her father to practise their Greek traditions.

Her father instructed her in mathematics and astronomy, and she became an expert in both. Soon she surpassed her father and produced important commentary on his mathematical work, while making her own contributions to geometry and number theory. Hypatia was also an expert in platonic philosophy. She was one of Alexandria's first female teachers. People travelled from faraway lands to hear her speak! Her male students gave her respect and loyalty.

Eventually the brewing religious tensions in the area turned violent, and Hypatia's 'pagan' teachings made her a target. She was killed around 415 CE by extremist Christians. Although her death was a tragedy, her life has become a symbol for education in the face of ignorance. We remember Hypatia as a source of light and knowledge.

HER FATHER WAS ONE OF THE LAST MEMBERS OF THE LIBRARY OF ALEXANDRIA.

INVENTED A NEW VERSION OF THE HYDROMETER.

SHE IS DEPICTED IN RAPHAEL'S FAMOUS PAINTING 'THE SCHOOL OF ATHENS'.

IS CITED IN AN ANCIENT ENCYCLOPAEDIA CALLED THE SUDA.

THE WISEST WAS KNOWN AS 'THE EGYPTIAN WISE WOMAN'.

THE LIBRARY OF ALEXANDRIA ENDURED WARS & REVOLTS. IT WAS DESTROYED IN 391 CE, WHEN THE ROMAN EMPIRE OUTLAWED PAGANISM.

WORKED WITH HER FATHER ON THEORIES ABOUT THE SOLAR SYSTEM.

MADE PUBLIC SPEECHES ABOUT PLATO & ARISTOTLE.

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'ART AND NATURE SHALL ALWAYS BE WRESTLING UNTIL THEY EVENTUALLY CONQUER ONE ANOTHER SO THAT THE VICTORY IS THE STROKE AND LINE.' – MARIA SIBYLLA MERIAN

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WANG ZHENYI

ASTRONOMER, POET AND MATHEMATICIAN

Wang Zhenyi was one of the greatest scholars in China. She was born in 1768 during the Qing dynasty. At the time, education was only for the wealthy and women were not expected to 'bother' with studies.

Fortunately, Wang Zhenyi was born into a family of scholars who valued her education. Her grandfather and father taught her astronomy and maths. She also travelled extensively and learned about the harshness of poverty, inspiring her to write poetry decrying injustice.

LOVED HER GRANDFATHER'S HUGE LIBRARY OF BOOKS.

EXPLAINED ECLIPSES IN HER PAPER 'THE DISPUTE OF THE PROCESSION OF THE EQUINOXES'.

In Wang Zhenyi's day, eclipses were not well understood. But she had theories about how they worked, and she created her own eclipse model using a mirror, a lamp and a globe. Wang Zhenyi used it to prove her theories about how the Moon blocks our view of the Sun – or the Earth blocks the Sun's light from reaching the Moon – during an eclipse. She also scientifically studied the Chinese calendar system and used her telescope to measure the stars and further explain the rotation of the solar system.

UNDERSTOOD THAT THE EARTH WAS ROUND AND DESCRIBED IT AS A BALL.

UPDATED THE COUNT AND PLACEMENT OF THE STARS.

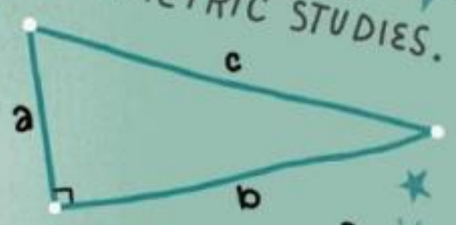
DEVELOPED HER OWN ARGUMENTS ON GRAVITY.

LEARNED FROM WESTERN & EASTERN CALENDARS.

WAS ACCOMPLISHED IN ARCHERY & HORSEBACK RIDING.

Wang Zhenyi only lived to the age of 29, yet she is remembered as a great mind of the Qing dynasty. She published many books on maths, astronomy and poetry, and her work influenced legions of scientists who came after her.

WROTE COMMENTARIES ON THE PYTHAGOREAN THEOREM AND OTHER TRIGONOMETRIC STUDIES.



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'THE GREATEST FOSSILIST THE WORLD EVER KNEW.' —*THE BRITISH JOURNAL OF THE HISTORY OF SCIENCE*

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MARY ANNING

FOSSIL COLLECTOR AND PALAEONTOLOGIST

HER DOG 'TRAY' CAME WITH HER ON FOSSIL DIGS UNTIL HE DIED IN A LANDSLIDE.

Mary Anning was born in 1799 in a small English seaside town called Lyme Regis. Her family was very poor, so she helped her father collect fossils to sell to tourists. It was dangerous work because the cliffs were steep, yet 11-year-old Mary took over the fossil business when her father died.

There was a time when people had never heard of dinosaurs and thought it was impossible for a species to go extinct. Mary helped to prove this wrong. When she was 12, she found the first complete ichthyosaur skeleton. She went on to discover two skeletons of the previously unknown species plesiosaur. These fossils were unlike any living animal, proving that extinction could occur. She also discovered the first pterosaur skeleton outside of Germany and many ancient fossilised fish. She helped determine that stones called bezoars were actually fossilised poo!

Mary was not allowed to publish work because she was a woman. Male doctors and geologists respected her ideas and used her findings in their own work, but her name was edited out. Although this was unfair, it was remarkable that a working-class woman was allowed to mingle with educated men in Victorian Britain.

Mary Anning's discoveries let the world see fossils as more than mystical oddities.

THERE IS A MYTH THAT HER GENIUS CAME FROM BEING STRUCK BY LIGHTNING AS A CHILD.

IT'S RUMOURED THAT 'THE TONGUE-TWISTER 'SHE SELLS SEA SHELLS' IS ABOUT MARY ANNING.

SHE SOLD FOSSILS TO NOBLE GENTLEMEN.

HER LIFE INSPIRED MANY MODERN FICTIONAL STORIES.

PEOPLE CALLED FOSSILS 'DEVILS TOENAILS' AND 'SNAKE STONES'.

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'IMAGINATION IS THE DISCOVERING FACULTY, PRE-EMINENTLY. IT IS THAT WHICH PENETRATES INTO THE UNSEEN WORLDS AROUND US, THE WORLDS OF SCIENCE.' – ADA LOVELACE

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ADA LOVELACE

MATHEMATICIAN AND WRITER

SHE DESCRIBED HERSELF AS A POETICAL SCIENTIST.

HER LAST NAME COMES FROM HER HUSBAND, WILLIAM KING, THE EARL OF LOVELACE.

ADA LOVELACE DAY IS CELEBRATED ON THE 2ND TUESDAY IN OCTOBER.

When Ada Lovelace first saw the Difference Engine, she became obsessed. The early computing pioneer Charles Babbage invented this gigantic, gear-filled calculator and, after meeting him in 1833, Ada convinced him to work with her.

Ada's mother, Anne Isabella Milbanke, was a mathematician who wanted the right upbringing for her daughter. Ada's father was the famed poet Lord Byron. The wildness that made him an amazing poet also made Byron a lousy husband, which led Anne to leave him after Ada was born. Ada was given an unusually strict mathematical education.

Ada met Charles Babbage when she was 17 and very persistent. She begged him to take her on as a student, but he was much too busy. So when Ada saw a French article about his newest idea, the Analytical Engine, she saw her chance to impress him. She translated the paper into English and published it in 1843. But that wasn't all; she added her own notes, making it twice as long! This got Charles's attention, and their collaboration began.

Ada imagined a world where computers did more than calculations – where they could write music and become extensions of human thought. She also designed a way to program the Analytical Engine, using punch cards with a sequence of rational numbers. It was the first computer program ever!

Ada remains an inspiration to this day. Her name has become proof that women can accomplish great things in technology, computing and programming.

SHE HAS INSPIRED CHARACTERS IN NARRATIVE & GRAPHIC NOVELS.

THE US DEPARTMENT OF DEFENSE NAMED A COMPUTER LANGUAGE 'ADA'.

SHE SIGNED HER LETTERS TO CHARLES BABBAGE AS 'LADY FAIRY'.

HER PROGRAM WAS INSPIRED BY THE PUNCH CARDS USED IN MECHANICAL LOOMS.

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'AN ERROR THAT ASCRIBES TO A MAN WHAT WAS ACTUALLY THE WORK OF A WOMAN HAS MORE LIVES THAN A CAT.' – HERTHA AYRTON

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HERTHA AYRTON

ENGINEER, MATHEMATICIAN AND INVENTOR

REGISTERED 26 PATENTS.

In 1854, Phoebe Sarah Marks was born in Britain. She was so energetic that her friends nicknamed her Hertha – after a German Earth goddess – a name she liked so much that she adopted it.

Hertha's family was poor, so at 16 she became a governess. There she met Madame Bodichon, a leader of the suffragist movement, who paid for Hertha's education. In technical school, she met Professor William Ayrton, who became her husband and partner in invention.

In the 1890s, hissing electric arcs were used for streetlights. William and Hertha wanted to improve the technology. One day, while William was away, Hertha invented a new arc that made a quiet bright light.

Hertha burst open doors for women by getting published and giving lectures on electricity. During demonstrations about the arc, people were amazed to see a woman wielding such dangerous-looking equipment! She was the first female member of the Institution of Electrical Engineers, but she was still not allowed to speak at the Royal Society. However, when her book *The Electric Arc* was published in 1902, it became too successful to ignore – the Royal Society let her present a paper. In 1906, they awarded her the Hughes Medal for her work on electricity.

Hertha was also a vocal advocate of the suffragist movement and provided aid to women on hunger strikes. In Britain's 1911 census, she wrote an impassioned letter on the form, demanding votes for women!

Hertha's genius paved the way for women to play with 'dangerous' machinery and invent great things.

WAS GOOD FRIENDS WITH MARIE CURIE.

STUDIED WIND MOTION AND WATER VORTICES.

NAMED HER CHILD AFTER MADAME BARBARA BODICHON, HER FRIEND & SUPPORTER.

WAS THE FIRST WOMAN NOMINATED TO BE A FELLOW OF THE ROYAL SOCIETY

(THOUGH THEY DID NOT OFFICIALLY ACCEPT WOMEN UNTIL THE 1990s).

INVENTED THE AYRTON FAN TO BLOW AWAY MUSTARD GAS DURING WORLD WAR I.

INVENTED A LINE DIVIDER FOR ARCHITECTS.

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CREATED A NEW THEORY OF NEUROSIS TO HELP PEOPLE COPE WITH ANXIETY.

NEUROSIS AND HUMAN GROWTH

HELPED CREATE A NEW FIELD OF PSYCHOLOGY CALLED NEO-FREUDIANISM.

DEVELOPED THE FOUNDATIONS OF FEMINIST PSYCHOLOGY.

'FORTUNATELY ANALYSIS IS NOT THE ONLY WAY TO RESOLVE INNER CONFLICTS. LIFE ITSELF STILL REMAINS A VERY EFFECTIVE THERAPIST.' —KAREN HORNEY

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