Henrietta Swan Leavitt was educated at Oberlin College and the Harvard-affiliated Radcliffe College before volunteering as an assistant at the Harvard College Observatory. She was employed at the observatory in 1907 by astronomer Edward Charles Pickering as one of the “human computers”, measuring the brightness of stars in the observatory’s photographic collection. At that time, women were not permitted to operate the observatory’s telescopes.

Leavitt was given the task of studying “variable stars” which vary in brightness over time. She recorded thousands of such stars in images of the Magellanic clouds and published the results, noting a recurring pattern in some of the stars, called Cepheid variables. In these stars, the luminosity of the star (the total amount of energy emitted) was strongly associated with the length of the pulsation period. The discovery had enormous implications. By observing the pulsation period, the luminosity of the star could be determined. In turn, the distance from the Earth to the star could be calculated by comparing its luminosity to its observed brightness.

Leavitt’s discovery was published by her supervisor, Edward Pickering, with Leavitt mentioned only as the person who prepared the information. She died an unknown astronomer, but after her death, her data was used by Edwin Hubble to understand the distance to Earth’s nearest large galaxy, and to determine that the universe is expanding.
Irene Joliot-Curie
(1897 – 1957)
Pioneering nuclear physicist

As the daughter of Marie and Pierre Curie, Irene was already part of a famous scientific legacy. A brilliant student, her studies were interrupted by the First World War, during which she worked with her mother in mobile field hospitals, operating the X-ray machines that her mother had developed. Both Irene and Marie eventually died from the consequences of radiation exposure.

After the war, Irene returned to Paris to study chemistry at her parents’ Radium Institute where she wrote her doctoral thesis about radiation emitted by polonium and met Frederic Joliot, who she married in 1926. The Joliot-Curies made a series of extraordinary discoveries over the course of their lifelong collaboration. They identified the positron and the neutron but failed to realise the significance of their results which was later claimed by others. In 1933, they discovered that by exposing aluminium foil to alpha particles, the aluminium became radioactive, showing that radioactive elements could be artificially produced from stable elements. Further discoveries included the creation of radioactive nitrogen from boron, radioactive isotopes of phosphorus from aluminium, and silicon from magnesium. Their work underpinned later research on radioisotopes and their practical applications, as well as uranium fission and the development of the atomic bomb.

In recognition of their work on new radioactive elements, the Joliot-Curies were jointly awarded the Nobel Prize in Chemistry in 1935.
Irish astrophysicist Dame Jocelyn Bell Burnell was a postgraduate student in 1967 when she discovered radio pulsars. These are rotating neutron stars that appear to 'pulse' because the light they emit can only be observed when they face the earth. The discovery is considered one of the greatest astronomical achievements of the twentieth century.

Burnell attended the University of Glasgow, studying a Bachelor of Science in Natural Philosophy (Physics). She then obtained a PhD from the University of Cambridge in 1969. While at Cambridge under the supervision of Antony Hewish, she detected a "bit of a scruff" on her chart recorder. Temporarily dubbed “Little Green Man 1”, the source was identified after several years as a rapidly rotating neutron star.

Since 1967, Burnell has worked at the University of Southampton, University College London, the Royal Observatory in Edinburgh, and the Open University. She was President of the Royal Astronomical Society from 2002-2004, and is currently a Visiting Professor of Astrophysics at the University of Oxford. In 1999 she was appointed Commander of the Order of the British Empire for services to Astronomy, and promoted to Dame Commander in 2007.

In 1974 the Nobel Prize in Physics for the discovery of radio pulsars was awarded to her thesis supervisor Hewish and astronomer Martin Ryle, despite Burnell having been the first to observe and analyse the phenomenon. The failure to include Burnell in the award has been strongly criticised by many prominent astronomers.
Katherine Johnson
(1918 - Present)
The Mathematician who Guided Spacecraft

A talented mathematician as a child, Johnson was admitted as a high school student at Institute, West Virginia when just 10 years old. She entered West Virginia State College at 14, graduating summa cum laude in 1937 with degrees in Mathematics and French. In 1953, after teaching for several years, Johnson was hired by the National Advisory Committee for Aeronautics (NACA), the early body of NASA. She worked as a ‘computer’ from 1953 until 1958 in the West Area Computers section and was later reassigned to the Guidance and Control Division of Langley’s Flight Research Division.

In 1961, Johnson calculated the trajectory of the flight of Alan Shepard, the first American in space, as well as the launch window for his Mercury mission that same year. A year later, when NASA used electronic computers to calculate John Glenn’s orbit around Earth, Johnson was called in to verify the numbers – Glenn having refused to fly until she did so.

In 1969, Johnson helped calculate the trajectory for the Apollo 11 flight to the moon and then worked on the Apollo 13 mission. It was Johnson’s work on backup procedures that helped set a safe path for the Apollo 13’s return to earth after the mission was aborted. Johnson continued to work for NASA until her retirement in 1986. Her contributions to the early space program have been celebrated in the 2016 movie Hidden Figures.
Lise Meitner studied physics under Ludwig Boltzmann at the University of Vienna. After obtaining her doctorate in 1906, Meitner went on to work with the chemist Otto Hahn, and continued to do so for 30 years. Meitner and Hahn lead a section in Berlin's Kaiser Wilhelm Institute for Chemistry, and collaborated in the study of radioactivity. In 1918 they discovered the element protactinium.

In 1922, Meitner also discovered the phenomenon whereby an atom with an electron vacancy in its inner shell becomes more stable by ejecting one or more electrons. This was later named the Auger Effect, after the French scientist Pierre Victor Auger who independently discovered the phenomenon a year after Meitner’s original finding.

After Austria was annexed in 1938, Meitner fled to Sweden where she continued her work at Manne Siegbahn's Institute in Stockholm. She had very little support, due to Siegbahn's prejudice against women in science. She met with Hahn again secretly in Copenhagen to plan and work on a new set of experiments. These experiments later provided evidence for nuclear fission, being made public in 1939. Later that year Meitner published the physical explanation for the observations. This led other scientists to prompt Albert Einstein to write a warning letter to President Franklin D. Roosevelt, culminating in the Manhattan Project.

Otto Hahn and Meitner were nominated for the Nobel Prize in both Physics and Chemistry several times, but in 1944 Hahn was solely awarded the Nobel Prize for Chemistry. Many years later, the papers of the Nobel Committee were made public, and Meitner’s exclusion has subsequently been described by her biographers as stemming from “a mixture of disciplinary bias, political obtuseness, ignorance, and haste.”
Maria Sibylla Merian was a 17th Century naturalist, entomologist, and botanical illustrator. David Attenborough has described her as one the most significant contributors to the field of entomology, and she is regarded as being one of the greatest botanical artists.

The young Merian began her artistic endeavours painting flowers, but at the age of 13 she became fascinated by insects, particularly caterpillars. Over the next few decades she recorded and illustrated the life cycles of 186 species. Her particular passion was the process of insect metamorphosis which she documented in great detail. In doing so she helping dispel the idea - first put forward by Aristotle - that insects were spontaneously generated, emerging from substances such as mud, dew, or even cabbages.

Merian wrote about insects and their habits, their food, and their place in ecosystems, with many of her engravings depicting ecological communities. Many historians of Science regard Merian as the first ecologist, two centuries before the word was invented.

Merian published several collections of engravings from 1675 to 1680. In 1699, at the age of 52, she undertook a remarkable 8000 km journey from the Netherlands to Suriname in South America. Accompanied only by her youngest daughter, she financed her journey by selling drawings. Merian's studies of the insects in the Suriname Jungles resulted in her great work, *Metamorphosis Insectorum Surinamensium*, published in 1705 and containing 60 remarkable copperplate engravings. This work introduced Europeans to an exotic natural world vastly removed from their own, describing such extraordinary natural phenomena as bird-eating spiders and leaf cutter ants.

Merian's work was extremely influential during her lifetime and was used by Swedish naturalist Carl Linnaeus to classify insects. But in the centuries that followed, the work was largely forgotten. Finally, in 2017, on the 300th anniversary of her death, a number of major exhibitions were mounted to celebrate her remarkable life and achievements.
Marie Tharp
(1920 – 2006)
Her Maps Changed Geology Forever

Born in 1920, Marie Tharp grew up in an era when women were not encouraged to make a career in science. When the Second World War took young men away from academic study, Tharp gained a place in the Earth Sciences Department at the University of Michigan. Here she was able to pursue an accelerated master’s degree in geology, and later, a degree in mathematics from the University of Tulsa. During her degree she was encouraged to develop drafting skills to increase her chances of finding work after the war ended. These skills proved critical to her later work.

In 1948, Tharp was employed at the Lamont Geological Laboratory at Columbia University where she worked with geologist Bruce Heezen to conduct the first systematic attempt to map the entire ocean floor. It was painstaking work – Tharp had to analyse vast numbers of sonar soundings and plot out the measurements by hand. Her greatest discovery occurred in 1953 when she found a huge valley in the middle of what is now known as the Mid-Atlantic Ridge, the Earth’s largest physical feature. This valley provided evidence that the sea floor was actually spreading, supporting the controversial idea first proposed in 1912 by the brilliant meteorologist Alfred Wegener. Wegener had noticed that the coastlines of South America and Africa seemed to fit together like a jigsaw, and also that similar fossils were found on different continents. He suggested that the Earth’s crust consisted of plates that moved - the concepts of plate tectonics and continental drift. His theory had been largely dismissed due to lack of convincing evidence.

When Tharp revealed her discovery of the valley and the Mid-Atlantic Ridge to Heezen he initially dismissed it as "girl talk". It took a year before he began to believe her, despite the body of evidence she had compiled. Heezen finally announced the findings in 1956 and published them in 1959. Tharp’s name does not appear on any of the major papers on the topic between 1959 and 1963. She was finally recognised much later in her life when in 1997, she was named as one of the greatest cartographers of the 20th century by the Library of Congress as part of the 100th anniversary of its Geography and Map Division. Perhaps too little, and too late.
Marjorie Courtenay-Latimer was an avid naturalist from a young age, and although trained to be a nurse, took a job as the founding curator of the Museum of East London, a coastal city in South Africa. She befriended local fisherman Captain Hendrick Goosen, and often inspected his catch for specimens to add to the museum’s collection. In December 1938, she noticed an unusual fish in Goosen’s catch, describing it as “the most beautiful fish I had ever seen, five feet long and a pale mauve blue with iridescent silver markings”. Unusually, the fish was nearly 60 kg, covered in hard scales and had four limb-like fins. Courtenay-Latimer didn’t know what it was, but recognized it was unusual and transported it back to the museum in a taxi. The museum’s chairman dismissed the find as being “nothing but rock cod”. But after examining reference books, Courtenay-Latimer concluded that the specimen was remarkably similar to a prehistoric fish called a coelacanth, believed to have become extinct at the end of the Cretaceous, more than 65 million years ago.

Courtenay-Latimer made a sketch of the fish and sent it to her friend James Smith at Rhodes University, a chemistry professor and fish enthusiast. In the meantime, she attempted to have the fish stored in the local morgue and then the cold storage depot, but was turned away from both. Eventually she sent the fish to a taxidermist who skinned and gutted the animal to preserve it.

Smith immediately confirmed Courtenay-Latimer’s suspicions that the find was a coelacanth, thought to be a “missing link” between fish and tetrapods, and described it as “the most important zoological find of the century”. The living fossil was eventually named Latimeria chalumnae in Courtenay-Latimer’s honour.
Mary Anning
(1799 - 1847)
She Sells Seashells...

Mary Anning made significant contributions the world of geology and the history of the Earth at a time when there was little evidence to challenge the biblical story of creation and the Great Flood.

Anning grew up in Lyme Regis, a coastal town in southern England surrounded by limestone cliffs rich in Jurassic fossils. The daughter of a carpenter and occasional fossil collector, she had very little formal education. The family lived in poor circumstances for most of their lives, surviving by selling fossils. In the early 1800s, Anning and her brother Joseph, still young children, discovered the first known specimen of Icthyosaurus subsequently acknowledged by the London Geological Society. By the mid-1820s, Anning had taken charge of the family’s fossil business and established her reputation within the fossil-collecting community.

Anning went on to discover several more ichthyosaur skeletons, but her most important find is considered to be the first known specimen of a plesiosaur, Pleiosaurus microcephalus, found in 1823. George Cuvier, the famous French anatomist, at first doubted this discovery, but his eventual recognition of the significance of the find helped establish Anning within the paleontological community. She later uncovered the first British flying reptile, Pterodactylus macrornyx, and a fossil fish that is a transitional link between sharks and rays, Squaloraja.

It has been speculated that Terry Sullivan’s lyrics “She sells seashells” was based on Mary Anning:

She sells seashells on the seashore
The shells she sells are seashells, I’m sure
So if she sells seashells on the seashore
Then I’m sure she sells seashore shells.

Despite being recognised by her own community, many of Anning’s finds have ended up in museums and private collections without attribution to their collector.

One hundred and sixty three years after her death, the Royal Society belatedly recognised Anning’s contributions when she was included in a list of ten British women considered to have most influenced the history of science.
Nettie Stevens (1861 - 1912)

Discovered Sex Chromosomes

Nettie Stevens trained as a high school teacher and librarian, enrolling at Leland Stanford University at the relatively advanced age of 35. A brilliant student, Stevens had broad interests in biology, including zoology, cytology, embryology and genetics and made substantial contributions to all of these fields. Her most significant contribution however, was to the field of chromosomal heredity — how sex is determined.

While studying the fertilization process of the mealworm, Stevens realised that chromosomes always existed in pairs and found that while male worms made reproductive cells with chromosomes of two types, female worms made reproductive cells with only one type. She concluded that sex is inherited as a chromosomal factor and that it is the males who determine the sex of their offspring — via the chromosome she named “Y”. Stevens' work titled Studies in Spermatogenesis, was published as a Carnegie Institute report in 1905.

Stevens' idea ran counter to the perceived wisdom of the time, that sex was determined by the mother and/or other environmental factors. A second researcher, Edmund Beecher Wilson, was conducting similar research at Columbia University, and had read Stevens' work before publishing his own findings. Stevens is now credited with having made a larger conceptual breakthrough.

Stevens died of breast cancer just 9 years after gaining her PhD.
Rosalind Franklin (1920 - 1958)
The Dark Lady of DNA

Rosalind Franklin studied physical chemistry at Cambridge University, earning her Ph.D. in 1945. She moved to Paris in 1947, where she worked at the Laboratoire Central des Services Chimiques de l'Etat, learning X-ray diffraction techniques.

When she was offered a three-year research scholarship at Kings College in 1951, she returned to England. X-ray crystallography was being studied at King's College by Maurice Wilkins, and Franklin arrived while he was away. When Wilkins returned, he assumed she had been hired as his assistant.

Working with student Raymond Gosling, Franklin was able to produce two sets of high-resolution photographs of crystallised DNA fibres. One of her photographs provided key insights into DNA structure, and she was able to deduce the basic dimensions of the DNA strands, with the phosphates on the outside of what was likely a helical configuration.

She presented her findings at a lecture in King's College in front of James Watson. Watson, along with Francis Crick, had been working on DNA structure at the Cavendish Laboratory. Wilkins showed Franklin's X-ray data to Watson and Crick, providing critical evidence for the 3D structure of DNA.

Franklin left Cambridge in 1953 and began working at the Birkbeck lab. She died in 1958 of ovarian cancer, perhaps brought on by her work with X-rays. She was 37. Four years later the Nobel Prize in Physiology or Medicine was awarded to James Watson, Francis Crick, and Maurice Wilkins for solving the structure of DNA.
The Scott Sisters
Harriet (1830 – 1907) & Helena (1832 – 1910)
Entomological illustrators extraordinaire

Helena “Nellie” Scott and her sister Harriet Morgan (née Scott) were prolific natural history illustrators and among the first professional female illustrators in Australia.

The Scott sisters were born in the Rocks in Sydney to a family of scientists and natural historians. Their father, Alexander Walker Scott, a noted entomologist, trained his daughters in natural history observation and illustration. After moving from Sydney to Ash Island in the Hunter River estuary in 1846, Harriet and Helena began drawing the native flora and fauna under their father’s tutelage.

Nearly twenty years later, the Scott sisters had completed a collection of drawings of moths and butterflies for their father’s publication, “Australian Lepidoptera and their Transformations”. The success of this publication brought many commissions, including James Charles Cox’s “Monograph of Australian Land shells” in 1868, Gerard Krefft’s “Snakes of Australia” in 1869 and “Mammals of Australia” in 1871. The paintings of the two sisters were renowned for their exquisite and life-like detail.

In the 1860s the sisters faced financial difficulties following the bankruptcy of their father and the deaths of their mother and Helena’s husband Henry Forde. They were forced to leave Ash Island and to seek payment for their work. Harriet eventually married Dr Cosby William Morgani, but Helena still faced financial difficulty. She persuaded the Australian Museum to publish what was left of the Lepidoptera material, purchased for £200 in 1884. Under Helena’s guidance, the museum published the second volume of the work in five parts between 1890 and 1898.

The Scott sisters continued to earn their living from drawing and painting, and are now considered two of Australia’s earliest professional illustrators. Their work continues to be showcased by the Australian Museum.
Vera Rubin (1928 - 2016)  
Discovered Dark Matter  

Vera Cooper Rubin became fascinated with space and astronomy as a child. In 1948 she graduated from the prestigious US women's college Vassar where she had received a scholarship and was the only astronomy major. When applying to graduate schools, Princeton informed her that the school “does not accept women” in the astronomy program – this rule remained until 1975. Rubin went on to study physics at Cornell, and then Georgetown University, where she received her PhD in 1954.

Working with her colleague Kent Ford in the 1970s, Rubin showed that the speed at which stars orbit around the centres of spiral galaxies is just as high at the fringes of the galaxies. This finding contradicted the Newtonian theory of gravitation. The only plausible explanation was that the mass of the galaxies must extend invisibly beyond the most distant stars. This excess mass is now known as dark matter, a concept that had first been proposed by Fritz Zwicky in the 1930s. Rubin's calculations indicated that galaxies must contain five to ten times as much dark matter as ordinary matter and these results were confirmed over subsequent decades.

Rubin was a tireless advocate of women in science and a passionate mentor of young women astronomers.