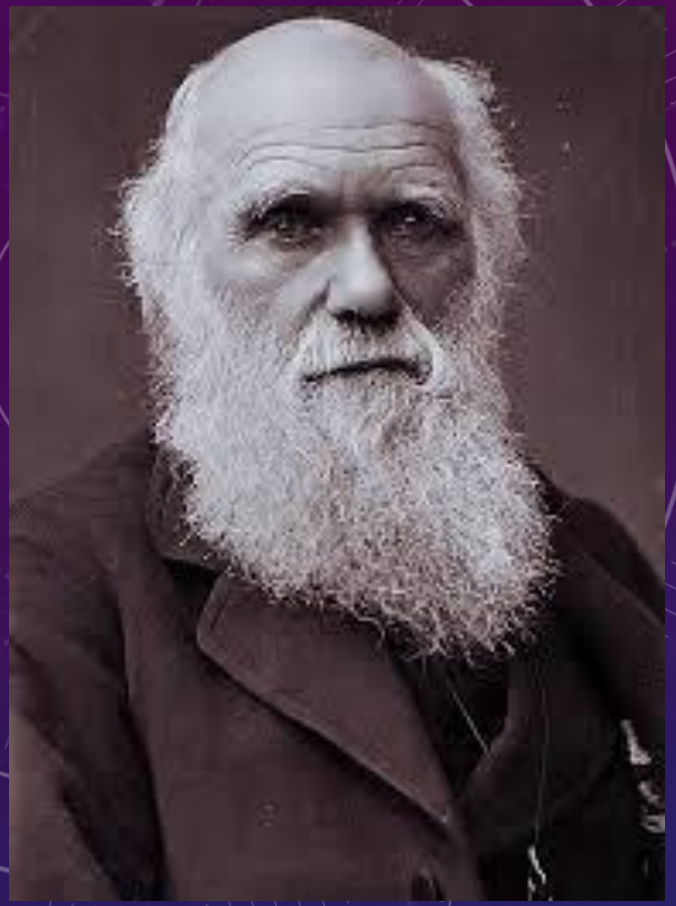


CHARLES DARWIN

MEGAN WARD

EARLY LIFE

- He was born in Shrewsbury, Shropshire, England, on February 12, 1809 at his family home, The Mount.
- He was the fifth of six children of wealthy doctor and financier Robert Darwin, and Susannah Darwin.
- He was the grandson of two prominent abolitionists: Erasmus Darwin on his father's side, and of Josiah Wedgwood on his mother's side.
- Both families were mostly Unitarian, though some were adopting Anglicanism.
- Robert Darwin, himself a freethinker, had Charles baptized in November 1809 in the Anglican St Chad's Church, Shrewsbury, but Charles and his siblings attended the Unitarian chapel with their mother.
- In 1817, his mother died. In September 1818, he joined his older brother Erasmus attending the nearby Anglican Shrewsbury School as a boarder.
- He spent the summer of 1825 as an apprentice doctor, helping his father treat the poor of Shropshire, before going to the University of Edinburgh Medical School, at the time the best medical school in the UK, with his brother Erasmus in October 1825.
- He found lectures dull and surgery distressing, so neglected his studies. He learned taxidermy from John Edmonstone, a freed black slave who had accompanied Charles Waterton in the South American rainforest, and often sat with this "very pleasant and intelligent man".

EARLY LIFE (CONTINUED)

- In Darwin's second year, he joined the Plinian Society, a student natural history group whose debates strayed into radical materialism.
- He learned classification of plants, and assisted with work on the collections of the University Museum, one of the largest museums in Europe at the time.
- The neglect of medical studies annoyed his father, who sent him to Christ's College, Cambridge, for a Bachelor of Arts degree. He joined the ordinary degree course in January 1828. He preferred riding and shooting to studying.
- His cousin William Darwin Fox introduced him to the popular craze for beetle collecting; Darwin pursued this zealously, getting some of his finds published in Stevens' Illustrations of British entomology.
- He became a close friend and follower of botany professor, John Stevens Henslow and met other leading naturalists who saw scientific work as religious natural theology, becoming known as "the man who walks with Henslow".
- When his own exams drew near, Darwin focused on his studies and was delighted by the language and logic of William Paley's Evidences of Christianity. In his final examination in January 1831 Darwin did well, coming tenth out of 178 candidates for the ordinary degree.
- Darwin stayed at Cambridge until June. He studied Paley's Natural Theology or Evidences of the Existence and Attributes of the Deity, which made an argument for divine design in nature, explaining adaptation as God acting through laws of nature.
- He read John Herschel's new book, which described the highest aim of natural philosophy as understanding such laws through inductive reasoning based on observation, and Alexander von Humboldt's Personal Narrative of scientific travels..

HMS BEAGLE

- Darwin got a letter from Henslow proposing him as a suitable naturalist for a place on HMS Beagle with captain Robert Fitz Roy. The ship was an expedition to chart the coastline of South America. Darwin’s father objected to his son's planned two-year voyage, seeing it as a waste of time, but was persuaded by his brother-in-law, Josiah Wedgwood, to agree to his son's participation.
- The voyage began on December 27, 1831; it lasted about five years.
- Darwin spent most of his time on land investigating geology and making natural history collections, while the Beagle surveyed and charted coasts. He kept careful notes of his observations and theoretical speculations, and at intervals during the voyage his specimens were sent to Cambridge together with letters including a copy of his journal for his family.
- He had some expertise in geology, beetle collecting and dissecting marine invertebrates, but in all other areas was a novice and ably collected specimens for expert appraisal. He wrote a lot of notes while on board the ship.
- On their first stop, ashore at St. Jago, Darwin found that a white band high in the volcanic rock cliffs included seashells.
- Fitz Roy had given him the first volume of Charles Lyell's Principles of Geology which set out uniformitarian concepts of land slowly rising or falling over immense periods, and Darwin saw things Lyell's way, theorizing and thinking of writing a book on geology.
- In cliffs near Punta Alta, Darwin made a major find of fossil bones of huge extinct mammals beside modern seashells, indicating recent extinction with no signs of change in climate or catastrophe. He identified the little-known Megatherium by a tooth and its association with bony armor which had at first seemed to him like a giant version of the armor on local armadillos.
- Further south, he saw stepped plains of shingle and seashells as raised beaches showing a series of elevations. He read Lyell's second volume and accepted its view of "centres of creation" of species, but his discoveries and theorizing challenged Lyell's ideas of smooth continuity and of extinction of species.

HMS BEAGLE (CONTINUED)

- As HMS Beagle surveyed the coasts of South America, Darwin theorized about geology and extinction of giant mammals.
- Unlike his scientist friends, he now thought there was no unbridgeable gap between humans and animals.
- Darwin experienced an earthquake in Chile and saw signs that the land had just been raised, including mussel-beds stranded above high tide. High in the Andes, he saw seashells, and several fossil trees that had grown on a sand beach. He theorized that as the land rose, oceanic islands sank, and coral reefs round them grew to form atolls.
- On the new Galápagos Islands, he looked for evidence attaching wildlife to an older "centre of creation", and found mockingbirds allied to those in Chile but differing from island to island. He heard that slight variations in the shape of tortoise shells showed which island they came from, but failed to collect them, even after eating tortoises taken on board as food.
- In Australia, the marsupial rat-kangaroo and the platypus seemed so unusual that Darwin thought it was almost as though two distinct Creators had been at work.
- The Beagle investigated how the atolls of the Cocos (Keeling) Islands had formed, and the survey supported Darwin's theorizing.
- In Cape Town, Darwin and Fitz Roy met John Herschel, who had recently written to Lyell praising his uniformitarianism.

EVOLUTIONARY THEORY

- When the Beagle reached Falmouth, Cornwall, on October 2, 1836, Darwin was already a celebrity in scientific circles as in December 1835. Henslow had fostered his former pupil's reputation by giving some naturalists a pamphlet of Darwin's geological letters.
- He hurried to Cambridge to see Henslow, who advised on finding naturalists available to catalogue the collections and agreed to take on the botanical specimens. Darwin's father organized investments, enabling his son to be a self-funded gentleman scientist, and Darwin went round the London institutions seeking experts to describe the collections.
- Charles Lyell met Darwin for the first time on October 29 and soon introduced him to the up-and-coming anatomist Richard Owen, who had the facilities of the Royal College of Surgeons to work on the fossil bones collected by Darwin.
- Owen's surprising results included other gigantic extinct ground sloths as well as the Megatherium, a near complete skeleton of the unknown Scelidotherium and a hippopotamus-sized rodent-like skull named Toxodon resembling a giant capybara. The armor fragments were actually from Glyptodon, a huge armadillo-like creature as Darwin had initially thought. These extinct creatures were related to living species in South America.
- In mid-December Darwin took lodgings in Cambridge to organize work on his collections and rewrite his Journal. The ornithologist John Gould soon announced that the Galapagos birds that Darwin had thought a mixture of blackbirds, "gros-beaks" and finches, were, in fact, twelve separate species of finches.
- On February 17, Darwin was elected to the Council of the Geological Society

EVOLUTIONARY THEORY (CONT.)

- Early in March, Darwin moved to London to be near this work, joining Lyell's social circle of scientists and experts such as Charles Babbage. Darwin stayed with his freethinking brother Erasmus.
- Gould met Darwin and told him that the Galápagos mockingbirds from different islands were separate species, not just varieties, and what Darwin had thought was a "wren" was also in the finch group. Darwin had not labelled the finches by island, but from the notes of others on the Beagle, including Fitz Roy, he allocated species to islands. The two rheas were also distinct species, and on March 14, Darwin announced how their distribution changed going southwards.
- By mid-March, Darwin was speculating on the possibility that "one species does change into another" to explain the geographical distribution of living species such as the rheas, and extinct ones such as the strange Macrauchenia which resembled a giant guanaco.
- His thoughts on lifespan, asexual reproduction and sexual reproduction developed in his "B" notebook around mid-July on to variation in offspring "to adapt & alter the race to changing world" explaining the Galápagos tortoises, mockingbirds and rheas.
- He sketched branching descent, then a genealogical branching of a single evolutionary tree, in which "It is absurd to talk of one animal being higher than another", discarding Lamarck's independent lineages progressing to higher forms.

OVERWORK AND ILLNESS

- While developing this study of transmutation, Darwin became mired in more work. Still rewriting his Journal, he took on editing and publishing the expert reports on his collections, and with Henslow's help obtained a Treasury grant of £1,000 to sponsor this multi-volume Zoology of the Voyage of H.M.S. Beagle, a sum equivalent to about £79,000 in 2013.
- He stretched the funding to include his planned books on geology, and agreed unrealistic dates with the publisher. As the Victorian era began, Darwin pressed on with writing his Journal, and in August 1837 began correcting printer's proofs
- Darwin's health suffered under the pressure. On September 20, he had "an uncomfortable palpitation of the heart", so his doctors urged him to stop his work and live in the country for a few weeks.
- After visiting Shrewsbury, he joined his Wedgwood relatives at Maer Hall, Staffordshire, but found them too eager for tales of his travels to give him much rest.
- His uncle Jos pointed out an area of ground where cinders had disappeared under loam and suggested that this might have been the work of earthworms, inspiring "a new & important theory" on their role in soil formation which Darwin presented at the Geological Society on November 1.
- William Whewell pushed Darwin to take on the duties of Secretary of the Geological Society. After initially declining the work, he accepted the post in March 1838.
- Despite the grind of writing and editing the Beagle reports, Darwin made remarkable progress on transmutation, taking every opportunity to question expert naturalists.

ILLNESS AND MARRIAGE

- Darwin chose to marry his cousin, Emma Wedgwood.
- The strain took a toll, and by June he was being laid up for days on end with stomach problems, headaches and heart symptoms.
- For the rest of his life, he was repeatedly incapacitated with episodes of stomach pains, vomiting, severe boils, palpitations, trembling and other symptoms, particularly during times of stress such as attending meetings or making social visits. The cause of Darwin's illness remained unknown, and attempts at treatment had little success.
- On June 23 he took a break and went "geologizing" in Scotland.
- Fully recovered, he returned to Shrewsbury in July.
- Used to jotting down daily notes, he scrawled rambling thoughts about career and prospects on two scraps of paper, one with columns headed "Marry" and "Not Marry". Advantages included "constant companion and a friend in old age ... better than a dog anyhow", disadvantages were "less money for books" and "terrible loss of time." Having decided in favor of marriage, he discussed it with his father, then went to visit Emma on July 29. He didn’t get around to proposing, but against his father's advice he mentioned his ideas on transmutation.

MALTHUS AND NATURAL SELECTION

- Continuing his research in London, Darwin's wide reading now included the sixth edition of Malthus's *An Essay on the Principle of Population*
- Darwin was well prepared to compare this to de Candolle's "warring of the species" of plants and the struggle for existence among wildlife, explaining how numbers of a species kept roughly stable.
  - As species always breed beyond available resources, favorable variations would make organisms better at surviving and passing the variations on to their offspring, while unfavorable variations would be lost.
  - He wrote that the "final cause of all this wedging, must be to sort out proper structure, & adapt it to changes", so that "One may say there is a force like a hundred thousand wedges trying force into every kind of adapted structure into the gaps of in the economy of nature, or rather forming gaps by thrusting out weaker ones." This would result in the formation of new species.
- By mid-December Darwin saw a similarity between farmers picking the best stock in selective breeding, and a Malthusian Nature selecting from chance variants so that "every part of newly acquired structure is fully practical and perfected", thinking this comparison "a beautiful part of my theory". He later called his theory natural selection.
- On November 11, he returned to Maer and proposed to Emma, once more telling her his ideas. She accepted, then in exchanges of loving letters she showed how she valued his openness in sharing their differences, also expressing her strong Unitarian beliefs and concerns that his honest doubts might separate them in the afterlife.
- On January 24, 1839 Darwin was elected a Fellow of the Royal Society.
- On January 29, Darwin and Emma Wedgwood were married at Maer in an Anglican ceremony arranged to suit the Unitarians,

GEOLOGY BOOKS, BARNACLES, EVOLUTIONARY RESEARCH

- His research included extensive experimental selective breeding of plants and animals, finding evidence that species were not fixed and investigating many detailed ideas to refine and substantiate his theory. For fifteen years, this work was in the background to his main occupation of writing on geology and publishing expert reports on the Beagle collections.
- Darwin's book *The Structure and Distribution of Coral Reefs* on his theory of atoll formation was published in May 1842 after more than three years of work, and he then wrote his first "pencil sketch" of his theory of natural selection. To escape the pressures of London, the family moved to rural Down House in September.
- By July, Darwin had expanded his "sketch" into a 230-page "Essay".
- In November the anonymously published sensational best-seller *Vestiges of the Natural History of Creation* brought wide interest in transmutation. Darwin scorned its amateurish geology and zoology, but carefully reviewed his own arguments. Controversy erupted, and it continued to sell well despite contemptuous dismissal by scientists.

GEOLOGY BOOKS, BARNACLES, EVOLUTIONARY RESEARCH (CONT.)

- Darwin completed his third geological book in 1846. He now renewed a fascination and expertise in marine invertebrates, dating back to his student days with Grant, by dissecting and classifying the barnacles he had collected on the voyage, enjoying observing beautiful structures and thinking about comparisons with allied structures.
- In 1847, Hooker read the "Essay" and sent notes that provided Darwin with the calm critical feedback that he needed, but would not commit himself and questioned Darwin's opposition to continuing acts of creation.
- In an attempt to improve his chronic ill health, Darwin went in 1849 to Dr. James Gully's Malvern spa and find some benefit from hydrotherapy. Then in 1851 his daughter Annie fell ill, and she died.
- In eight years of work on barnacles (Cirripedia), Darwin's theory helped him to find "homologies" showing that slightly changed body parts served different functions to meet new conditions, and in some genera he found minute males parasitic on hermaphrodites, showing an intermediate stage in evolution of distinct sexes. In 1853 it earned him the Royal Society's Royal Medal, and it made his reputation as a biologist.
- In 1854, he became a Fellow of the Linnean Society of London, gaining access to its library. He began a major reassessment of his theory of species.

DARWIN'S THEORY OF EVOLUTION

- Natural selection states that evolutionary change comes through the production of variation in each generation and differential survival of individuals with different combinations of these variable characters. Individuals with characteristics which increase their probability of survival will have more opportunities to reproduce and their offspring will also benefit from the heritable, advantageous character. So over time these variants will spread through the population.
- Darwin's five theories were:
  - Evolution: species come and go through time, while they exist they change.
  - Common descent: organisms are descended from one, or several common ancestors and have diversified from this original stock
  - Species multiply: the diversification of life involves populations of one species diverging until they become two separate species; this has probably occurred billions of times on earth!
  - Gradualism: evolutionary change occurs through incremental small changes within populations; new species are not created suddenly.
  - Natural selection: evolutionary change occurs through variation between individuals; some variants give the individual an extra survival probability.

PUBLICATION OF THE THEORY OF NATURAL SELECTION

- By the start of 1856, Darwin was investigating whether eggs and seeds could survive travel across seawater to spread species across oceans.
- When he read a paper by Alfred Russel Wallace, "On the Law which has Regulated the Introduction of New Species", he saw similarities with Darwin's thoughts and urged him to publish to establish precedence. He continued his researches, obtaining information and specimens from naturalists worldwide including Wallace. The American botanist Asa Gray showed similar interests, and on September 5, 1857 Darwin sent Gray a detailed outline of his ideas including an abstract of Natural Selection.
- Darwin's book was only partly written when, on June 18, 1858, he received a paper from Wallace describing natural selection. Shocked that he had been "forestalled", Darwin sent it on that day to Lyell, as requested by Wallace, and although Wallace had not asked for publication, Darwin suggested he would send it to any journal that Wallace chose. After some discussion, Lyell and Hooker decided on a joint presentation at the Linnean Society on July 1 of *On the Tendency of Species to form Varieties*; and on the *Perpetuation of Varieties and Species by Natural Means of Selection.*

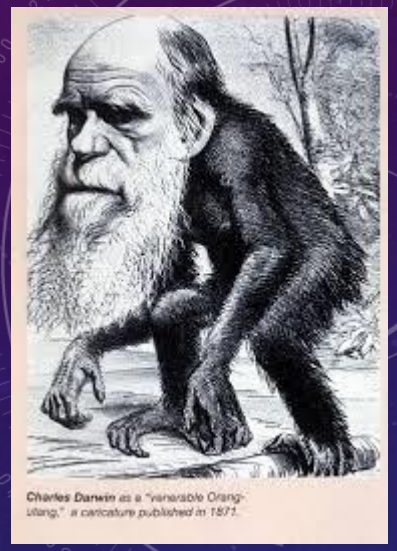
PUBLICATION OF THE THEORY OF NATURAL SELECTION

- On the evening of June 28, Darwin's baby son died of the scarlet fever, and he was too distraught to attend.
- There was little immediate attention to this announcement of the theory. Only one review rankled enough for Darwin to recall it later; Professor Samuel Haughton of Dublin claimed that "all that was new in them was false, and what was true was old." Darwin struggled for thirteen months to produce an abstract of his "big book", suffering from ill health but getting constant encouragement from his scientific friends. Lyell arranged to have it published by John Murray.
- On the Origin of Species proved unexpectedly popular, with the entire stock of 1,250 copies oversubscribed when it went on sale to booksellers on November 22, 1859. In the book, Darwin set out "one long argument" of detailed observations, inferences and consideration of anticipated objections.
- “As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.”
- “There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.”

RESPONSES TO PUBLICATION

- The book aroused international interest, with less controversy than the popular *Vestiges of the Natural History of Creation*. Though Darwin's illness kept him away from the public debates, he commented on press cuttings, reviews, articles, satires and caricatures, and corresponded on it with colleagues worldwide.
- The first review claimed it made a creed of the "men from monkeys" idea from Vestiges.
- The Church of England's response was mixed. Darwin's old Cambridge tutors Sedgwick and Henslow dismissed the ideas, but liberal clergymen interpreted natural selection as an instrument of God's design, with the cleric Charles Kingsley seeing it as "just as noble a conception of Deity".
- In 1860, the publication of Essays and Reviews by seven liberal Anglican theologians diverted clerical attention from Darwin, with its ideas including higher criticism attacked by church authorities as heresy. In it, Baden Powell praised "Mr. Darwin's masterly volume [supporting] the grand principle of the self-evolving powers of nature".

RESPONSES TO PUBLICATION (CONT.)


Charles Darwin as a "venerable Orang-utang," a caricature published in 1871.

- The most famous confrontation was in public, the 1860 Oxford evolution debate during a meeting of the British Association for the Advancement of Science, where the Bishop of Oxford Samuel Wilberforce, argued against Darwin's explanation and human descent from apes.
- Even Darwin's close friends Gray, Hooker, Huxley and Lyell still expressed various reservations but gave strong support, as did many others, particularly younger naturalists.
- Darwinism became a movement covering a wide range of evolutionary ideas. In 1863 Lyell's Geological Evidences of the Antiquity of Man popularized prehistory, though his caution on evolution disappointed Darwin.
- Darwin was awarded the Royal Society's Copley Medal on November 3, 1864. By the end of the decade, most scientists agreed that evolution occurred, but only a minority supported Darwin's view that the chief mechanism was natural selection.
- The Origin of Species was translated into many languages, becoming a staple scientific text attracting attention from all walks of life.
- Darwin's theory also resonated with various movements at the time and became a key fixture of popular culture.
- Cartoonists parodied animal ancestry in an old tradition of showing humans with animal traits, and in Britain these images served to popularize Darwin's theory in an unthreatening way.
- While ill in 1862, Darwin began growing a beard, and when he reappeared in public in 1866 caricatures of him as an ape helped to identify all forms of evolutionism with Darwinism.

OTHER WORKS

- By 1878, Darwin had suffered years of illness.
- Despite repeated bouts of illness during the last twenty-two years of his life, Darwin continued to work. He pressed on with experiments, research, and writing of his "big book". He covered human descent from earlier animals including evolution of society and of mental abilities, as well as explaining decorative beauty in wildlife.
- Enquiries about insect pollination led in 1861 to novel studies of wild orchids, showing adaptation of their flowers to attract specific moths to each species and ensure cross fertilization.
- In 1862 *Fertilization of Orchids* gave his first detailed demonstration of the power of natural selection to explain complex ecological relationships, making testable predictions.
- *The Variation of Animals and Plants under Domestication* of 1868 was the first part of Darwin's planned "big book", and included his unsuccessful hypothesis of pangenesis attempting to explain heredity. It sold at first, despite its size, and was translated into many languages. He wrote most of a second part, on natural selection, but it remained unpublished in his lifetime.
- With *The Descent of Man*, and *Selection in Relation to Sex* published in 1871, Darwin set out evidence from numerous sources that humans are animals, showing continuity of physical and mental attributes, and presented sexual selection to explain impractical animal features as well as human evolution of culture, differences between sexes, and physical and cultural racial characteristics, while emphasizing that humans are all one species.
- In his 1872 book *The Expression of the Emotions in Man and Animals* discussed the evolution of human psychology and its continuity with the behavior of animals.
- His evolution-related experiments and investigations led to books on Insectivorous Plants, *The Effects of Cross and Self Fertilization in the Vegetable Kingdom*, different forms of flowers on plants of the same species, and *The Power of Movement in Plants*. In his last book he returned to *The Formation of Vegetable Mould through the Action of Worms.*

DEATH

- He died on April 19, 1882.
- He was arranged to be buried in Westminster Abbey, close to John Herschel and Isaac Newton. The funeral was held on Wednesday April 26 , and was attended by thousands of people, including family, friends, scientists, philosophers and dignitaries.