Back in England, Darwin plunges into his work

- Researches and works on writing books:
  - *Journal of Researches (Voyage of the Beagle)*
  - *Zoology of the Voyage of the Beagle*
  - Elected Secretary of the Geological Society of London
  - Elected a Fellow of the Royal Society (F.R.S)

Darwin enlists leading naturalists to examine and classify his specimens.

- Richard Owen works on the fossil mammals.
- John Gould studies the bird specimens and informs Darwin that many of his Galápagos specimens are "a series of ground Finches which are so peculiar" as to form "an entirely new group, containing 12 species."
“Seeing this gradation and diversity of structure in one, small, intimately related group of birds, one might really fancy that from an original paucity of birds in this Archipelago, one species had been taken and modified for different ends.”

1839 - Darwin began a series of secret notebooks on the transmutation of species.

“I determined to collect blindly every sort of fact that could bear in any way on what are species. From this work I became convinced that species are not immutable. It is like confessing a murder.”

• Darwin questioned farmers and pigeon fanciers to find out how much animals could be changed by selective breeding.
Darwin saw that selective breeding could produce remarkably different forms in different breeds of pigeons, dogs, cows, and other domesticated animals.

But how does nature select for traits in the wild?

While thinking about how species might change, Darwin read an essay on overpopulation by the conservative economist Thomas Malthus.

Overpopulation is inevitable, and leads to the death of those least able to fend for themselves.

Darwin’s Laboratory at Down House

By the end of 1838, Darwin had a working hypothesis for explaining how species could change over time in a way that left them adapted to their circumstances.

Noting that individuals of a species appeared to be inherently variable, Darwin reasoned that in the struggle for existence, individuals with the most favorable variations would survive and reproduce, passing on those variations to their offspring. Individuals with unfavorable variations would die or fail to reproduce.

“This preservation of favourable variations and the rejection of injurious variations, I call Natural Selection.”

Thomas Malthus (1766-1834)
Individuals vary in their traits

This process repeats itself with each generation

Reproduction makes an excess of offspring (Malthus)

Evolution through Natural Selection

Offspring with traits well-suited to the environment survive and reproduce.

Offspring with unfavorable traits fail to survive or reproduce

Darwin’s Developing Theory

• Organisms naturally produce many more offspring than the environment can sustain (from Malthus).
• Offspring are naturally variable (from breeders, naturalists)
• Some offspring are more suited to the conditions of the environment - they survive and reproduce.
• Other offspring are less “well adapted” - they die without reproducing (natural selection).
• The survivors pass on their successful traits to the next generation, which repeats the process (like a breeding program).
• Over many, many generations, a species accumulates traits that are well suited to the environment, creating the appearance of design.
• Eventually the species diverges enough from its ancestral form that it becomes a new species.

Emma Wedgewood

• 1839 Darwin marries cousin Emma Wedgewood.
• 1842 Darwin and Emma settle at Down House.
• 10 children, 2 died in infancy, 1 at the age of 10 (Annie).
Darwin continued to research his natural selection theory as he continued to publish works on Geology and the Beagle voyage. He spent 8 years studying barnacles and published a monograph on their classification that cemented his reputation as a biologist.

- 1842 - Darwin writes a 230 page essay on his theory, but he refuses to publish it, asking his wife to do so in the event of his death.
- 1858 - Alfred Russell Wallace sends Darwin an abstract: *On the Tendency of Varieties to Depart Indefinitely from the Original Type.*

My God!!
I’ve been forestalled!
On the Origin of Species

- Wallace’s paper and an abstract by Darwin are read together at a meeting of the Linnean Society - neither is able to attend.
- Darwin rushes to complete a book length treatment of his theory.

- 1859 Darwin publishes *On the Origin of Species by Means of Natural Selection*.  
  - The book is a sensation.
  - By 1876 it has sold over 16,000 copies in England and has been translated into every major language.

“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.”

Darwin’s Accomplishments in the *Origin*

- Marshaled a large body of evidence in support of the fact of evolution (that all species are descended from other species).
- Developed a materialistic (non-supernatural) explanation for the formation of new species and for the appearance of design in adaptation.
- Mechanism of natural selection is plausible and testable.
- Darwin understood that Humankind could not be excluded from his theory.

“light will be thrown on the origin of man and his history”

Darwin’s Unknowns

- Did not know where variations came from.
- Did not know how variations were passed on through generations.
- Genetics not invented until early 20th Century.
- Was unable to directly observe or measure natural selection.