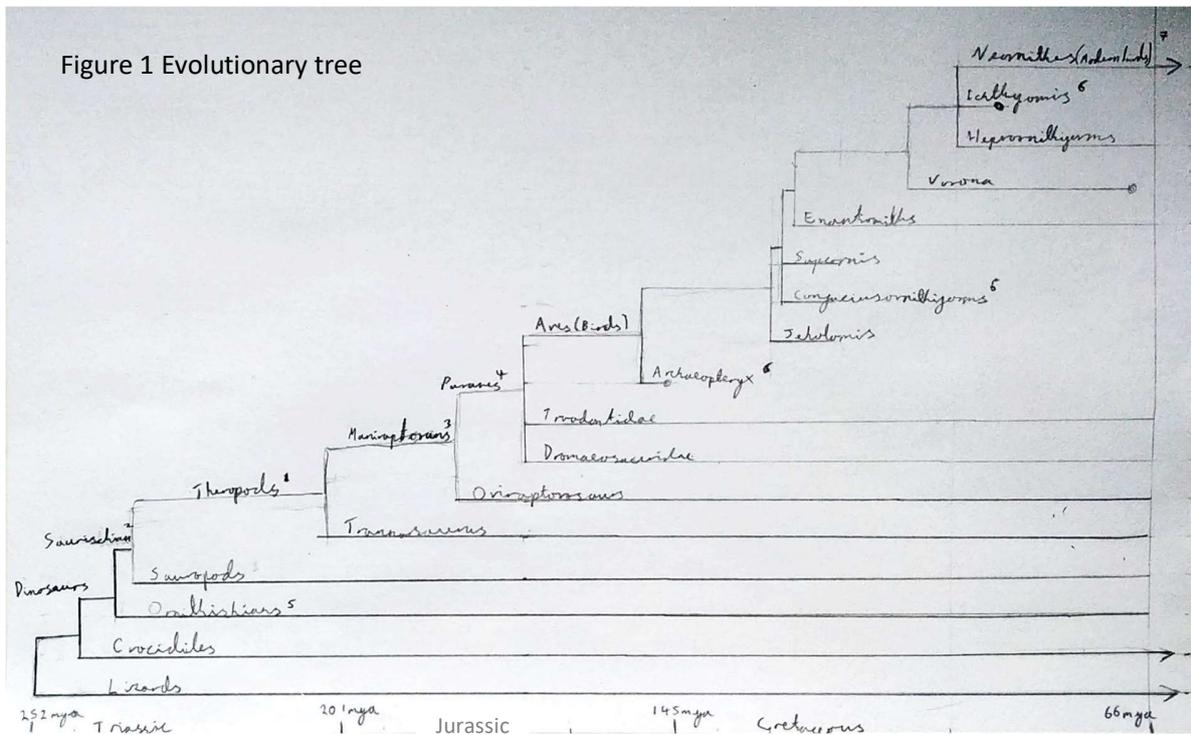


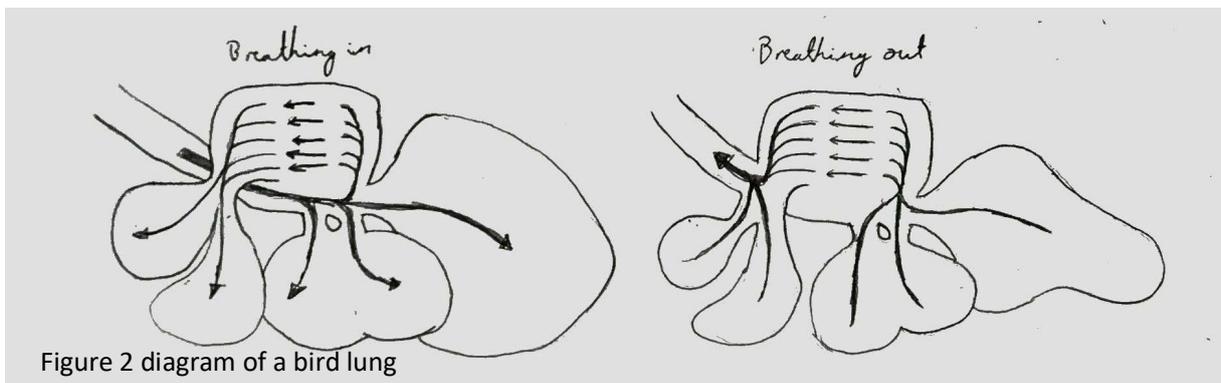
## How birds evolved flight

Birds are not the first species to evolve true flight and are not the last but they have the most diverse styles of flight. True flight is an uncommon natural ability and for birds involves many traits to develop on their evolutionary path, which can be traced back to the dinosaurs in the Triassic period.



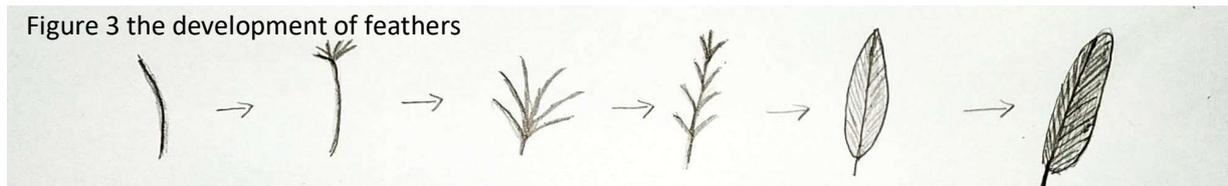
The first major trait is bipedalism that some dinosaurs evolved including theropods<sup>1</sup>, a branch of saurischian<sup>2</sup> dinosaurs. An upright posture is key to helping modern birds fly when taking off and landing, however this isn't the reason this trait became dominant. Bipedalism was advantageous because it increased energy conservation and agility, which made the trait more likely to survive.

Birds have an efficient breathing system, which allows them to fly in low oxygen environments, at high altitudes, and more energy to fly long distance. A unidirectional lung probably developed before dinosaurs, as lizards and crocodiles have this system. However, early dinosaurs developed two sets of air sacs, which allowed for a larger air capacity and constant oxygen in the lungs. Probably to increase energy produced to run faster or to survive in a low oxygen atmosphere.



Modern birds are able to fly due to their light weight and rigid skeleton. Theropods had light, hollow bones to increase their acceleration and a furcula (wishbone), which is the two collar bone fused together, was rigid enough to withstand more powerful muscles, increasing the speed.

Another key feature are their feathers. Primitive, wire-like feathers (which are seen on many dinosaurs such as the Tyrannosaurus rex) are likely to have been for insulation. While vaned feathers, which developed in maniraptorans<sup>3</sup>, were likely to be used for display or camouflage, as they have the same structure as tail feathers.



Wings are essential to a bird's ability to fly and control that flight. At first wings, which developed in paraves<sup>4</sup>, were to shade young, a mating or intimidation display, regulate body temperature or to run faster. Then, after their wings developed more muscles and asymmetrical feathers (that increase up thrust) they could glide and eventually fly creating the first birds (Aves).

As birds evolved during the Cretaceous Period many traits developed to help flight. It's hard to pinpoint when birds evolved beaks but as four-legged ornithischians<sup>5</sup> and other branches of birds<sup>6</sup> evolved beaks, it is likely birds had beaks as a tool to replace arms. More fused bones, such as a fused tail, created a rigid skeleton able to withstand vigorous flying. Birds also evolved a singular ovary, which lowers weight and increases space for air sacks for the trade-off of less eggs at a time.

Birds are a highly developed species that have survived for millions of years, including the mass extinction 66 million years ago<sup>7</sup>. Showing that flight is one of the most complex interesting abilities, as well as an advantageous one.