The Evolution of Flight

After the discovery of Archaeopteryx in the 1860s, the earliest known lineage of birds, there was uncertainty over what precisely happened following the evolution of dinosaurs into birds. Although the archaeopteryx had feathers, it was considered an intermediate between birds and reptiles. Only in the 1970s did palaeontologists realise they shared similar features with small theropods, the ancestors of birds.

This poses the question: how did these dinosaurs weighing 100-500 pounds develop wings despite their heavy weight and short arms? The answer: paedomorphosis. As it was revealed birds are almost identical to embryos of Velociraptors (a type of theropod dinosaur), birds resemble infant dinosaurs. In turn, this potentially caused miniaturisation as the development into adulthood stopped, preventing growth, paving the way for further adaptations. For example, when their bodies got smaller, their thigh bone became angled, shifting their centre of gravity forward, pushing them into a tilted position and making their wings nearer the centre of gravity. However, they still couldn't fly. Thus, Kenneth Dial proposed wings were used for running up steep inclines to gain traction and propelling them up slopes, known as wing assisted incline running (WAIR), enabling them to chase insects, climb trees, leap and glide, eventually evolving into flight.

Another adaptation suited for flying is pneumatization where the air sacks of birds can fill bones with air. Pneumatized bones are lighter instead of made from heavier marrow, decreasing their weight, making it easier to fly. Containing special strats to strengthen bones, they can become stronger than mammals. As their leg bones are usually heavier, likely due to the angled thigh bone because a crouched position requires more muscular effort, the strengthened bones compensate for the heavier weight on their legs. They also have another purpose. High altitudes involved with flying means there's less oxygen; a bird requires higher intake. Having air sacks with pneumatized bones allows gasses to flow out quicker, giving birds a constant supply of air therefore more oxygen enters the blood supply. As only fresh air flows into the lungs, they have a unidirectional system. This adaptation is likely linked to dinosaurs as pneumatic faramina (holes in the bone that connect to air-filled inner chambers) have been found in theropods and sauropod dinosaurs. Furthermore, in birds, specific bones are pneumatized by specific air sacs. Thus, we can discover which air sacks dinosaurs could have possessed by linking them together. Following this process, they likely had air sacs in-front of and behind their lungs hence potentially having a unidirectional respiratory system like birds.

Finally, there's the adaptation of feathers. Originally, hair-like feathers were believed to provide insulation but in dinosaurs including oviraptorosaurs who had long feathers it was believed to be used for protecting eggs. Anchiornis had a feather arrangement nearly identical to flight feathers except they were symmetrical rather than asymmetrical, suggesting they were too weak for flying instead for attracting mates like peacocks. To summarise, there are multiple theories on the purpose of feathers before flight depending on the structure of feathers.