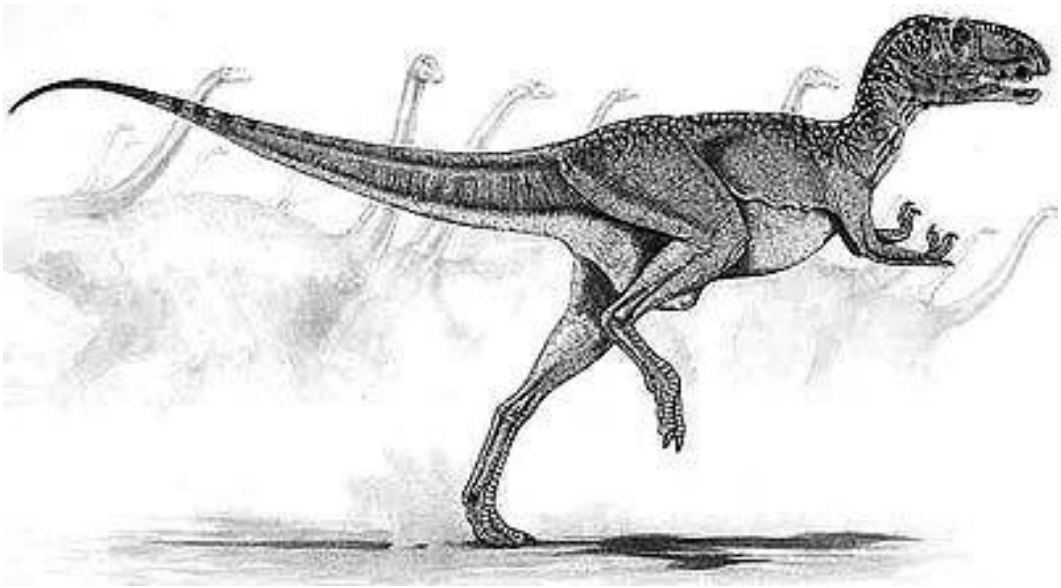
Reptile to Bird: Archaeopteryx: The Transitional Fossil

1. **Feathers**: Scales gradually modified into complex feathers. These first provided insulation to trap body heat, and later helped with gliding, display, and flight.
2. **Skeletal shrinking**: Bodies became much smaller and lighter over time. Skulls also adopted a juvenile, baby-like shape even into adulthood.
3. **Bony tail reduction**: The long, heavy dinosaur tail shrank into a tiny stump and fused into a small bone called a **pygostyle** to improve balance and air control.
4. **Wings and arms**: Front limbs grew longer and stronger, shifting the primary mode of movement from running to flapping flight.
5. **Legs**: Back legs grew less powerful, weaker and thinner. Circulation changed to allow the legs to tolerate cold conditions without frost bite.
6. **Wishbone and breastbone**: A large, keeled breastbone developed to anchor powerful flight muscles, supported by a fused collarbone (the wishbone) to act as a spring during wing strokes.
7. **Respiratory system**: Lungs evolved into a specialized system with hollow, pneumatic bones and **air sacs** that constantly cycle air to supply the massive amounts of oxygen needed for flight.
8. **Tooth loss**: Early transitional species like *Archaeopteryx* had teeth, but modern bird lineages eventually lost them entirely in favor of lightweight keratin beaks.
9. **Digestive**: Entire change in the digestive system from meat and plants to seeds, insects, fruits and nuts.
10. **Flight:** As apex predators using strong offense with physical traits like speed, powerful jaws, strong leg sprinting and head crest, they transitioned to an avoidance creature by running up trees and ground-up flapping.
11. **Heart**: transitioned from 3 chamber to 4 chamber with new plumbing. Science News: *https://www.sciencenews.org/article/three-four-chambers* "The major question has been, what drove the evolution of the four-chambered heart?" comments James Hicks, an evolutionary biologist at the University of California, Irvine.
12. **Temperature Control:** Most reptiles are cold blooded. Birds are warm blooded. Birds have to make and control their body head. Ectothermic vs. endothermic.
13. **Operating System**: The brain and nervous system have to reconfigure to operate its new features: heart, digestion, respiratory, legs, etc.



Theropod



Archaeopteryx